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THE JOURNAL OF THE NATIONAL DENTAL ASSOCIATION

1921

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A Study of the Temporomandibular Joint—*Williams*

Studies in Root-Canal Sterilization —*Marshall*

Crown and Bridge-Work from a New Point of View—*Orton*

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H. E. Friesell (1), President, and Otto U. King (2), Secretary, National Dental Association, Honored Guests at California State Dental Association Banquet, at San Francisco, February 21, 1921

THE JOURNAL
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Original Communications

A CLASSIFICATION OF TEETH THE DISEASED PULPS AND APICES OF WHICH ARE RELATED TO INFECTIVE FOCAL AND SYSTEMIC SEQUELAE [1]

By CLARENCE J. GRIEVES, D.D.S., Baltimore, Maryland

(Read before the Atlantic Midwinter Clinic, Atlanta, Georgia, March 4, 1920)

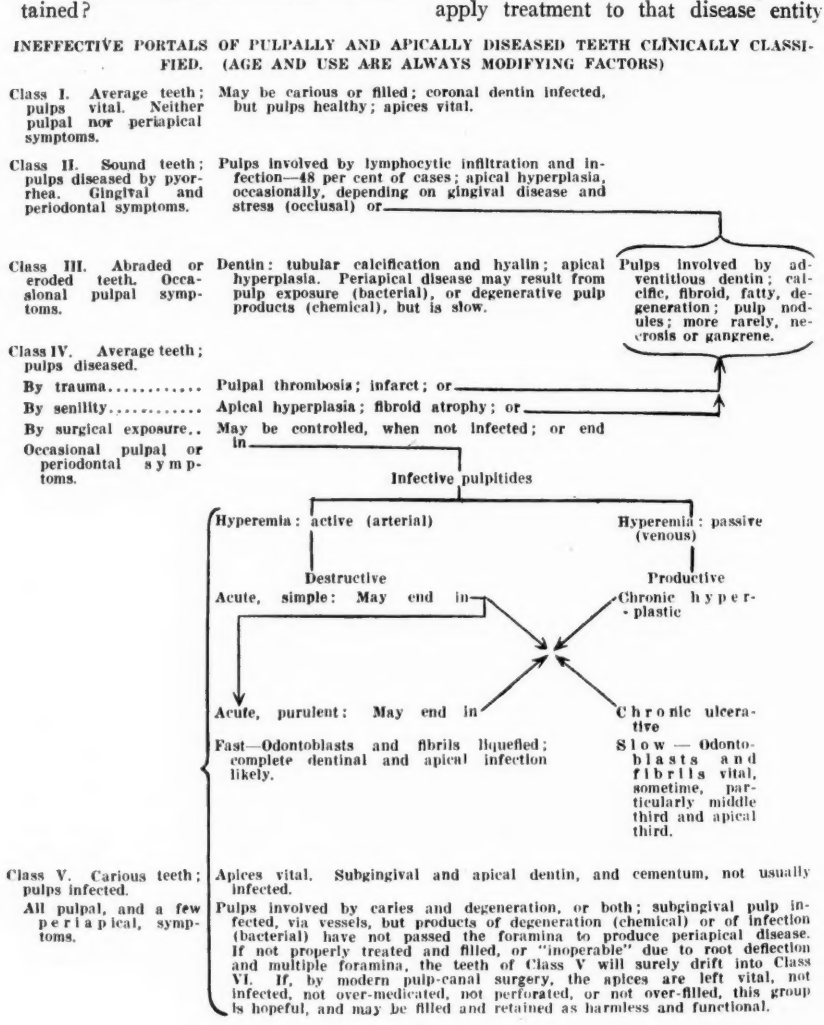
SO HEATED is current discussion of so-called "pulpless," "dead," or "non-vital" teeth; so many bodily ills of doubtful etiology, hence treated experimentally, are said to have been caused by "non-vital" teeth and cured by the removal of such teeth from the maxillae; so doubtful pathologically are these ills; so questionable is the right to the claim "cured," when applied either to the chronic *systemic* or to the equally chronic *oral* diseases that these and other reasons prompt a pause by both dental and medical professions, in order the better to classify and define the pathology, not only of "pulpless" teeth, but of all other teeth, invaded by pathogenic bacteria.

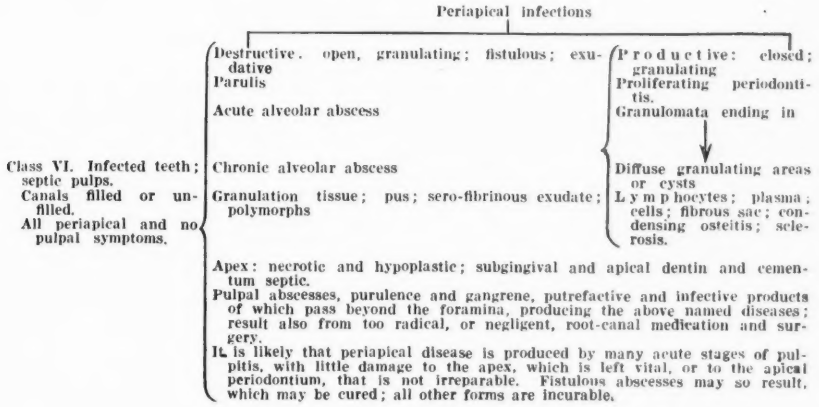
Such a working classification (16), crude but practical, was presented by the writer eighteen months ago; and, recently, at the last meeting of the National Dental Association. It will be attempted again, but it must be accepted as a clinical presentation only, for, as the matter now stands, it is next to impossible for dentists to consult intelligently among themselves upon this subject. How, then, can they expect their medical confreres to comprehend in oral pathology what, to their own minds, is

[1] This paper, to which additions have been made, was first read before the First District Dental Society, New York City, February 2, 1920.

not clear? Is it any wonder that our medical confreres, not understanding, condemn all "filled pulpless teeth," overlooking many others more virulently diseased, and doubt the judgment of any dentist who honestly insists that certain types of diseased teeth are both harmless and functional, hence should be retained?

Any intelligent discussion of this subject is necessarily based upon certain facts, which must be considered axiomatic, even tho subject to correction in the light of the constantly accruing results of research, like all other scientific data. Upon such clinical axioms we must all agree, just as we accept and apply treatment to that disease entity


INEFFECTIVE PORTALS OF PULPALLY AND APICALLY DISEASED TEETH CLINICALLY CLASSIFIED. (AGE AND USE ARE ALWAYS MODIFYING FACTORS)
Class I. Average teeth; pulps vital. Neither pulpal nor periapical symptoms.
May be carious or filled; coronal dentin infected, but pulps healthy; apices vital.
Class II. Sound teeth; pulps diseased by pyorrhea. Gingival and periodontal symptoms.
Pulps involved by lymphocytic infiltration and infection—48 per cent of cases; apical hyperplasia, occasionally, depending on gingival disease and stress (occlusal) or
Class III. Abraded or eroded teeth. Occasional pulpal symptoms.
Dentin: tubular calcification and hyalin; apical hyperplasia. Periapical disease may result from pulp exposure (bacterial), or degenerative pulp products (chemical), but is slow.
Pulps involved by adventitious dentin; calcific, fibroid, fatty, degeneration; pulp nodules; more rarely, necrosis or gangrene.
Class IV. Average teeth; pulps diseased.
By trauma.....
Pulpal thrombosis; infarct; or
By senility.....
Apical hyperplasia; fibroid atrophy; or
By surgical exposure..
May be controlled, when not infected; or end in
Occasional pulpal or periodontal symptoms.
Infective pulpitides
Hyperemia: active (arterial)
Hyperemia: passive (venous)
Destructive
Productive
Acute, simple: May end in
Chronic hyperplastic
Acute, purulent: May end in
Chronic ulcerative
Fast—Odontoblasts and fibrils liquefied; complete dentinal and apical infection likely.
Slow — Odontoblasts and fibrils vital, sometime, particularly middle third and apical third.
Class V. Carious teeth; pulps infected.
Apices vital. Subgingival and apical dentin, and cementum, not usually infected.
All pulpal, and a few periapical, symptoms.
Pulps involved by caries and degeneration, or both; subgingival pulp infected, via vessels, but products of degeneration (chemical) or of infection (bacterial) have not passed the foramina to produce periapical disease. If not properly treated and filled, or "inoperable" due to root deflection and multiple foramina, the teeth of Class V will surely drift into Class VI. If, by modern pulp-canal surgery, the apices are left vital, not infected, not over-medicated, not perforated, or not over-filled, this group is hopeful, and may be filled and retained as harmless and functional.


Periapical infections
Class VI. Infected teeth; septic pulps. Canals filled or unfilled. All periapical and no pulpal symptoms.
Destructive. open, granulating; fistulous; exudative
Parulis
Acute alveolar abscess
Chronic alveolar abscess
Granulation tissue; pus; sero-fibrinous exudate; polymorphs
Productive: closed; granulating
Proliferating periodontitis.
Granulomata ending in
Diffuse granulating areas or cysts
Lymphocytes; plasma; cells; fibrous sac; condensing osteitis; sclerosis.
Apex: necrotic and hypoplastic; subgingival and apical dentin and cementum septic.
Pulpal abscesses, purulence and gangrene, putrefactive and infective products of which pass beyond the foramina, producing the above named diseases; result also from too radical, or negligent, root-canal medication and surgery.
It is likely that periapical disease is produced by many acute stages of pulpitis, with little damage to the apex, which is left vital, or to the apical periodontium, that is not irreparable. Fistulous abscesses may so result, which may be cured; all other forms are incurable.

known as dental caries, while disagreeing as to its etiology. These facts should be couched in the language common to general, not merely to oral, pathology, so that all pathologists may understand when we speak of the etiology and pathology of pulpal and apical diseases, all of which, if properly classified, would indicate the correct treatment and prognosis. Not only would this course greatly clarify the subject in our own minds and save countless, otherwise functional, teeth, but it would promote a better understanding, and closer co-operation, between both dental and medical professions.

If many of the facts submitted are bromidic and appear too elementary, let us remember that eventually we must return again and again to first principles; it is only by orientation of these, to recent methods of practice, that real truth will survive. Your attention is, therefore, directed briefly to the histopathology of the two main dental portals by which pathogenic organisms approach the pulp and subapical tissues, and thereby the lymph channels and blood stream, namely, (a) the dentin, pulp and root apex, and (b) the gingival crevice.

Discussion of the Classification

Class I—Average teeth; pulps vital

Class I, which may be carious, while both pulps and apices are vital and healthy, is necessarily a broad one, since all teeth that have been carious or restored by filling, within the prescribed limits of the class, belong to this group and lead to a moment's consideration of dental caries.

Many phases of tooth destruction exist which cannot be classed under erosion, abrasion, or caries. However, the disease group known under the broad term, dental caries, must be so accepted. Like many other wasting diseases, its etiology is unsettled. Whether we hold with those who consider acidophilic forms as the only cause; or believe these active in symbiosis with cocci; or again, that various streptococcal strains are the only factors, three facts are assured clinically:

(1) Streptococci constitute 50 per cent of all mouth growths of microörganisms and often are apparently normal in healthy oral and pharyngeal mucosae [Kligler and Gies (22); Hartzell and Henrici (19).]

(2) Pathogenic coccal forms have been demonstrated repeatedly, by culture and in slides, lying deep in the tubuli of vital dentin, under soft caries, and

after thoro cavity preparation. [Miller (25), Goadby (9), Hopewell-Smith (21), Hartzell and Henrici (19), Rosenow (30).]

(3) Miller (25) and others identify cocci as the deepest invaders of the dental pulp.

Attention is called to this septic factor in all stages of dental caries, hence:

Conclusion 1. Dental caries is dual in character, being a chronic tooth-wasting disease, with tissue necrosis or liquefaction superficially, and pathogenic forms irregularly invading the hard underlying dentinal matrix. This sepsis begins in the granular layer of Tomes, and is the primary infective focal portal. Therefore, because dentin is hard, or free from soft caries, it is not necessarily free from bacteria; and some effort must be made to sterilize every cavity-preparation in vital teeth.

It is probable that such latent infection exists in every well filled tooth, as it does in every carious tooth. Fortunately, the infection is merely latent and rises to the dignity of disease only when it involves the pulp. Disease is prevented (a) orally, by scientific filling-restoration, checking recurrent caries; and (b) cavally, by dentinal tubular calcification, granular hyalin formation or adventitious dentin—the usual dentinal protection, of which Hopewell-Smith (21) says: "Probably nearly every dentinal change is accompanied by some healing process of the pulp." This resistance reverses the rule, being less active in young adolescent dentin, with many tubuli or little matrix substance, than in adult or middle life. If, by reason of rapid and virulent caries, or a lack of resistance, these pulp reactions break down, much chronic pulp disease may occur under good fillings, with solid but infected dentin intervening, eventually producing periapical disease, while the dentin is sensitive and the pulp vascular.

We should be mindful of this infective element in treating children's teeth, particularly first molars. A deep cement filling or pulp capping (the proper procedure) often fails to protect the pulp because of collateral dentinal infection. Possibly, these are the most insidious and dangerous of all periapical types of infection.

What is conservative practice for Class 1, in the light of the foregoing? With dentinal infection controlled, and the wonderful pulpal resistance still functioning in a vast majority of cases, do we stand with the "devitalists," who would remove a pulp before it becomes infected, because sometime this function may fail? Or, have we such confidence in our canal technic as to devitalize and positively (?) remove every particle of pulp, and fill every root, where occurrences of apical deflection and multiple foramina are at least 40 per cent (16), with perfect root fillings in only 7 per cent of the cases (of thousands) and with 47.5 per cent of all filled roots apically diseased?

The operator who proceeds to devitalization, in spite of these facts, assumes a reparative skill more potent than the human body possesses. If he succeeds, it is usually not by his skillful technic, important tho that may be, but in spite of it—by remarkable reparative processes in the periodontium and vital apex. Hence:

Conclusion 2. The normal pulps of vital teeth should be devitalized rarely, and only when devitalization is important for the construction of such occlusal restorations as are impossible by other methods and absolutely necessary to general nutrition; recalling the 70 per cent of occlusal efficiency of bridges, as compared with 30 per cent in the case of dentures.

The possibilities of modern partial dentures and attachments, which have been so markedly improved, conserving rather than destroying attaching teeth, must be thoroly studied and exhausted before it is decided to risk devitalization of a normal pulp.

Class II—Sound teeth; pulps diseased by pyorrhea

It is not proposed, in discussing Class II, to dwell upon gingival diseases, except as they tend to produce pulpal or periapical disease.

Dewey and Noyes (7, 8) have demonstrated the association of three sets of lymph vessels with the blood supply that completely surrounds every tooth, which is seated, so to speak, in a basket of periodontal membrane, dense socket lining (lamina dura), and blood vessels, all of which tissues these lymph vessels penetrate, nourish, and drain. The largest group passes from the gingiva, centrally down thru the membrane, paralleling the cementum; it is joined by gingival and middle-third groups, the first of which carries infection from the gingival crests to the nearest lymph nodes. Thus, a superficial gingival infection would be deflected over the interseptal crests; but a periodontal infection would finally reach the subapical tissues, splitting the periodontal membrane on its way, as in a true pyorrhea pocket.

At this point we would impress you with the results of recent research by Henrici and Hartzell (20) who, in studying one hundred coronally sound, but pyorrheal teeth, found 48 per cent of the vital pulps invaded by lymphocytic infiltration and the vessel walls much damaged, with coccal forms definitely established in the tissue. These findings should settle the question of hematogenous pulp infection. The round-cell infiltration is a counterpart of the cell reaction in adjacent tissue, previously noted, by Latham (23, 24) and Talbot (31), as pulp degeneration, associated with interstitial gingivitis. But the presence of pathogenic bacteria is a new highly significant fact, about which centers many possibilities, among them the following.

(1) Periapical disease is not coincident with gingival lesions; it does not arise in the same percentage of cases, nor occur in 48 per cent of sound pyorrheal teeth, the pulps of which show lymphocytic invasion and pathogenic bacteria. On the contrary, casual clinical observation shows that many pulpless teeth, 47.5 per cent of which are apically diseased, are the only teeth remaining firm and free from gingival disease in an entire denture swaying in purulence. This may be due to sclerosis or a condensing osteitis, which often involves the apical- and middle-third attachments of such teeth, making them firmer than those adjacent. This condition, by partially destroying the lower lymph system, would present a barrier against further periodontal invasion.

(2) That this 48 per cent incidence of pulp pathology does not always produce a like amount of periapical disease may be explained by the fact that coincident with pulp disease gingivally induced necessarily runs a pyorrhea that destroys the gingival-third fibers, and creates a compensating hyperplasia of the apical-third fibers and cementum to meet extra stress. Thus, the accessory, often the main, foramina, are closed and the entire apex is encased with laminae of adventitious cementum, which may seal this portal against infection, either afferent or efferent. Further, in any serious loss of gingival tissue resulting in exposure of cementum, pulpal fibrotic and calcific degeneration is common. This interferes with complete pulp removal and root-canal filling, which, in these cases, is below the average for all pulpless teeth. In fact, the high percentage of failures to fill apices and the low percentage of periapical diseases is notable, apical hyperplasia (and often a real hypercementosis) commonly existing, having closed this whole region against both pulpal and gingival infection, before the dentist could reach it.

Be these hypotheses what they may, it is safer to assume, for teeth involved by gingival disease, that sepsis might at any time reach apical and pulp tissues, since

the main lymph flow is from gingiva to subapical tissues; and to add, to the usual conservative rule (15), that "pyorrheal teeth, gingivally damaged to the middle third and swaying in purulence, must be removed," the further practice stated in the following conclusion:

Conclusion 3. Any pulpless tooth, the periodontal membrane of which is gingivally purulent, should be removed, no matter how perfectly filled, or how well repaired subapically, whether periapically diseased or not; for, at any time, it might become diseased by the gingival pathway. If pulp devitalization is absolutely necessary, it should be practiced on only such pyorrheal teeth as are not swaying to the middle third; or those cured (?) by peridontic treatment; and then, on only those in which apical hyperplasia has closed in part the foramina as noted. (Such hyperplasia is usually demonstrable, clinically and by good radiographs.)

The fact that 48 per cent of the pulps of gingivally diseased teeth are infected will not, it is to be hoped, lead to a new fad for the destruction of these pulps—just as all pulpless teeth are now being removed because they are interstitially infected. The situations are analogous and comparable. It has been shown that real periapical disease (one of the good reasons for tooth extraction) does not result in anything like the same proportion, from demonstrated pulp disease, as it does from the best efforts to remove such pulps.

A large percentage of dentinal infection never reaches the pulp to produce pulpitis, just as, no doubt, a similar percentage of cases of pulpitis never reaches the subapical tissues to induce disease outside the tooth. These are latent infections constantly occurring elsewhere thruout the body, in connective tissue, particularly bone, from the vascularity of which they are definitely walled off by sclerosis and repair. You are referred, in this connection, to the remarkable work of Sir Kenneth Goadby (9, 10, 11), on latent infections in war wounds. Bacteria occur, isolated, in the solid matrix of sclerosed or repaired bone; and should rarely be disturbed, except when surrounded by, or enclosing, infected granulations, as in apical condensing osteitis or "loculi," constituting a real bone pathology.

Classes III and IV—(III) Abraded or eroded teeth occasional pulpal symptoms; (IV) average teeth: pulps diseased

It is in Classes III and IV (abraded, eroded and senile, coronally sound teeth: all conditions free from caries, infection, and gingival lesions, except clean gingival atrophy, which is not infective), that a most remarkable demonstration of the possibilities of the pulp as a reparative organ occurs. This is true up to a certain plane, after which, a gradual failure of function begins, the pulp displaying a singular inability to complete repair, so well begun, which results in complete degeneration.

This we recognize as inevitable, to be expected of this type of tissue, because of its peculiar vascularity, and its confined position and location as an end organ; but we must remember, according to Hopewell-Smith (21), "that nearly every degree of dentinal change is attended with hyperaemia and cell proliferation in the pulp tissue, and, generally speaking, formation of adventitious dentin." By tubular calcification and granular hyalin formation, the normal pulp responds successfully to erosive and abrasive dentinal invasion, supplementing this resistance against chemical and mechanical irritants by deposits of adventitious dentin on the approximating pulpal walls, or by pulp-nodule formation interstitially. This is typical normal defense, similar to that elicited in dental caries, but free from infection.

Such irritation in "one pulp may produce similar reactions in others of the

same denture; pulp nodules are found at all ages and stages of all pulp disease" (26). Hence, such evidences of irritation are not definitely symptomatic. Degeneration may result at any time: and, except by referred pain or the radiograph, which are not definite, or by exploration and pulp removal, both destructive, we have no sure diagnostic methods, for thermal and faradic electric tests are misleading. Eventually, a series of symptoms of subapical disease arise in the periodontium, but these are periapical not pulpal.

With the advent of the gold inlay, applied to replace gold shell-crowns covering sound teeth ground down years ago, we have been given proof of Broomell's contention (5) that tubular calcification and much adventitious dentin result possibly from dentinal irritation from grinding, exposure to thermal change, or cements. In recent cavity preparations, areas of sensitive dentin are found in such teeth; the pulps are frequently degenerate, but little pulpitis or apical disease is present, except in those previously infected thru deep carious cavities. Many such have been restored to full function by M. O. D. inlays. The shell-crown should, therefore, be condemned; if need be, not for the pulpitis it induces but for the gingival disease resulting from its careless use.

Arteriosclerosis is associated with pulp degeneration; but diseased pulp vessels are commonly sclerosed, without systemic hypertension symptoms. Advancing age is a real factor, these conditions being rare in the young. We know that senility induces, in sound teeth, fatty or mucoid degeneration of odontoblasts, the entire pulp becoming fibrotic, sclerosed, or partially or completely calcified. Any of these conditions may end in gangrene, infectious or otherwise. But we know no better way of determining the progress of this course of events, inside the tooth, save by appearance, than we have in the patient from his history and facies.

It has been the practice not only to blame pulp degeneration for causing periapical disease, but also to remove such pulps in the hope of preventing the putrefactive (not infective) products of degeneration from causing such disease. It has also been the fashion to speak of hematogenous pulp infection in these groups, and also in coronally sound teeth with the pulps non-vital from trauma. In the light of quoted research, neither practice nor theory in these respects is tenable. It is more than likely that nearly all periapical disease, except that produced by the dentist chemically—by radical canal medication—results from the arrival in the pulp of a real infection via the dentinal tubuli or by pulp exposure, or via the gingival lymph vessels, producing chronic pulpitis, the toxic products of which in turn produce periapical infection. And it seems that apical disease is just as rarely produced by chemical products of pulp degeneration, minus infection, as is pulpal infection, in sound teeth, the result of hematogenous convey.

The pulps of coronally sound teeth, which are necrosed or gangrenous, present necrotic masses entirely devoid of normal tissue-elements, and may become infected, involving the apex at any time, with no pulpal but many peridontal symptoms. This process is slow, however, and such gangrene is often walled off, even in the dental pulp, according to Witzel and Arkövy, by a "line of demarcation" of granulation tissue, the subgingival remainder being in a passive (venous) hyperemic state, when vascular stasis usually results, with less liability of toxicity appearing beyond the foramina before the pulp can be removed.

Until better diagnostic methods are devised, we deduce the following:

Conclusion 4. Unless pulp symptoms or exposure arise in eroded, abraded or

senile teeth, it is meddlesome practice to risk pulp devitalization and defective canal filling, just because pulps *might* degenerate, the exception to this rule being pyorrheal teeth, which might be infected by the gingival pathway.

In all stages of degeneration, except the calcific, when the pulp is finally infected by opening the pulp cavity or otherwise, periapical disease is both rapid and virulent. This is to be expected and illustrates a lack of the usual resistance, resident in healthy dentin and pulp; for pulp cells are fibrotic, fatty or gangrenous, as are the fibrillae. The entire tooth is thus a perfect culture tube.

Conclusion 5. Cases in Class IV (fresh surgical exposure of symptomless pulps, made thru hard dentin, even at the risk of its being infected) are hopeful. Capping should be attempted, with frequent clinical and radiographic survey; but the slightest periodontal symptoms demand immediate pulp removal. This is especially true of young unfinished apices, which should be considered with a full understanding of the results of the recent research on apical cementum by Box (3).

No pulp exposure with the least symptoms of any disease, except calcific degeneration, should be capped, for periapical infection is inevitable, insidous, and symptomless, hence dangerous.

Class V—Carious teeth; pulps infected

Class V (carious teeth, infected pulps, but subgingival dentin not completely infected, with the apices free from disease and vital) is most interesting, because it is in this group that the profession, in the past, has done its best work.

In spite of infected and defective canal work and so-called "useless medication" (before the advent of the radiograph), it can be shown that a large percentage of such teeth were preserved, and are harmless and functional today, notwithstanding the fact that the pulpitides of this group are the principal portals for the production of periapical disease, and that pulp diagnosis was crude and inaccurate. The errors of the past lay not alone in septic canal work, nor in empirical treatment, but in the empirical dictum that every tooth must be saved at all hazards, and also in failures of both treatment and judgment in the selection of teeth for treatment, no distinction having been made between those of Class V, with vital apices, and of Class VI, which were hopelessly abscessed.

It is always instructive, even if humiliating, to review past failures. In the following statistics, instances of periapical disease, diagnosed clinically and by radiograph, are rated as failures, a percentage of which no doubt occurred prior to treatment and should appear under apically diseased teeth in Class VI. The number of rarefactions, mistaken for real bone lesions, would likewise greatly lower these ratios in favor of the apically well-filled pulpless tooth.

In all data submitted, the radiograph and its interpretation is a determining factor. While open to criticism, which will be discussed later, the radiograph, within clinical limitations, is the means by which the extensive occurrence of such lesions was first definitely discovered, not only about teeth, but in many other organs. It is still accepted as a most valuable diagnostic adjunct by the surgeon, so this is hardly the time for dentists to quibble over it.

Quoting from a previous compilation (16) of the results of the work of Callahan, Grove, Hyatt, and the writer, we find that only 7 per cent of root apices were ever perfectly filled and 53 per cent of these were periapically diseased. But of this 7 per cent, only 2 per cent showed filling material in the accessory foramina. Yet we know that these, as well as apical deflections, occur in at least 40 per cent of all teeth.

Hence, in 38 per cent of "perfectly" (?) filled apices, the accessory foramina were not filled by filling material, but by pulp-shreds and vessels, vital or non-vital. Further, available filling materials (gutta-percha usually) contract at body-temperature at least one-fourth in bulk (28), allowing seepage of exudates and bacteria. Thus very few apices, in all their ramifications, have ever been filled.

In the same report, consider the data for poorly filled roots (fillings ending short of the apical third): 43 per cent of these occurred, but only 57 per cent were periapically diseased; and these, like the perfectly filled, may have been diseased before filling. Thus, we find approximately one-half of both perfectly and imperfectly filled roots periapically diseased.

The second compilation is from Arthur Black's (2) "summary of abscesses related to root fillings," a report on six thousand dental radiographs of six hundred unselected adults. It is more fairly divided into percentages of small and large roots. It defines a good root filling as one appearing well into the apex, with no open canal beyond it; a bad root filling as not reaching the apex, projecting beyond it, or permitting the existence of a definitely open canal beyond the filling. In this report, 45 per cent of all filled roots were periapically diseased but only 9 per cent of these occurred about good root fillings, while 63 per cent involved poorly filled apices.

All of this is most encouraging to those who would save and not extract the teeth of Class V. The 50 per cent of the first report and the 45 per cent of the second report, average 47.5 per cent of all filled roots as apically diseased, leaving a balance of 52.5 per cent not visibly diseased.

What of this 52.5 per cent? If it does not represent a composite of the patient's general resistance, and a local resistance existing in and about the tooth, plus average dental skill and effort in the past, what does it indicate? Who, and what, retained these teeth to function to the patient's great comfort, if the conservative dentist did not? Surely not the "100 per cent vitality men," both doctors and dentists, who extract all filled pulpless teeth. We are not disputing the fact that the remaining 47.5 per cent, apically diseased, were a menace to the patient's maxillae and adjacent teeth, if not to his general health, for undoubtedly they were and should have been removed immediately. But, in taking thought, it is good to realize that, by modern diagnostic, clinical, and surgical methods, even a much larger percentage of the teeth in Class V may be prevented from drifting into Class VI.

Any attempt to explain this 52.5 per cent of pulpless teeth, that apparently were not periapically diseased, leads immediately into intricate questions of pulp pathology and symptomatology that can be discussed only clinically at this time.

It is recognized that various stages of pulpitis merge into each other more or less gradually and that these pathological phases may be fairly accurately defined in the laboratory, with a pulp slide in hand; but no associated definite set of symptoms differentiate such conditions in the pulp in situ. "Relative response to thermal change, dentin appearance and sensation, indefinite thermal and electric tests, or pain principally, which is rarely localized, appear to be our all, symptomatically, as indicated by the pulp. . . . . When sepsis passes out the apex, the damage we would avert has been done, and on outspoken group of symptoms present, but these are periapical, not pulpal. . . . . This is well illustrated by the treatment for pulpitis, which, notwithstanding a voluminous pathology, with few exceptions, is still pulp destruction" (16). If pulp diagnosis were accurate, periapical disease could be prevented, but with our present knowledge, "the treatment, pulp removal, unfortunately anticipates and is the pulp diagnosis" (16).

With this understanding, the prevention of periapical infection, by assisting normal tissue resistance and causing delay in extension of infection to the apex, by prompt pulp surgery and proper treatment, becomes a matter of the greatest importance. The first line of dentinal defense has been explained; it is frequently adequate, otherwise all carious and filled teeth would contain septic pulps, since caries is partially a septic process. The second occurs interstitially after actual pulp invasion. This resistance is best described by Hopewell-Smith (21), who says: "It is not at all surprising that this is a structure, which possesses great recuperative power, and is constantly exercising its functions in this respect, and undergoing repair; hence, any invasion by disease or the occurrence of an accident is succeeded by a resistance, which, in many cases, is highly satisfactory."

The chances for apical infection can best be grasped, by a comprehension of Prinz's (29) classification of pulpitides into (a) those which are *rapid*—the acute, destructive types, i.e., acute, simple, and purulent pulpitis; and (b) those which are *slow*—the chronic, productive types, i.e., chronic ulcerative and hypertrophic pulpitis. In any clinical discussion of pulpitides, Noyes' remark in this relation must always be kept in mind. He says (26): "There is the greatest difference in the rapidity with which these stages follow each other and the extent to which the inflammation spreads thru the tissue before the breaking down begins. This is probably due to the character of the invading organism and the resistance of the individual."

In acute destructive types, the entire pulp may rapidly become purulent or liquefied, odontoblasts and fibrils may become necrotic, and complete dentinal and apico-cemental infection occur, when acute or chronic apical diseases quickly follow. Or, thrombosis and infarct may induce gangrene, which has been described as slowly involving the apex; or both phases may be subacute, and result in chronic ulcerative or hyperplastic stages. But, as a rule, acute pulpitis is dangerous, producing apical disease before the pulp can be removed. In chronic productive types, the situation is much more hopeful, and dentinal and pulpal resistance more active; for the odontoblasts and fibrils are not quickly liquefied and protect the subgingival dentin for some time. Coronally, infection may progress between the odontoblasts and pulpal walls, but subgingivally and apically this layer remains well attached and more or less vital.

Below the gingivae, infection primarily follows a central course along the great vessels, attacking the pulpal-wall tissue later. Occasionally, the perivascular lymphatics convey bacteria and toxins thru the foramina, producing periapical disease, while the pulp is still sensitive and vascular, and the apex vital—a very dangerous condition. Usually, however, there is much delay, and time enough to prevent apical disease by pulp removal. Particularly is this true of hyperplastic types, where a productive cell reaction, with much granulation tissue often covered by epithelium (as in pyorrhea), is associated with pulpal tumor. Resistance to infection is high in, and infection is slow in passing thru, foramina; in these, prompt clean canal surgery should leave an uninfected vital apex and functional tooth.

The following deductions are, therefore, justified, from the standpoint of histopathology, as relating to conditions that guard the apex and prevent or delay its infection.

(A) In chronic pulpitis, and certain stages of pulp degeneration and gangrene, complete destruction of the subgingival odontoblasts and fibrillae is usually a slow process. Persistence of this layer of cells, vitally attached to pulpal walls, has been noted by many histologists, for all pulp diseases. It

guards the apical third of the dentin, possibly transmitting sensation, which often persists, indicating a vital apex. Such would not be the case, if this layer was necrotic or liquefied.

(B) Pulpal infection is generally localized centrally. Excepting the initial lesion, the carious exposure, it follows the large vessels and perivascular lymphatics centrally thru the pulp, leaving tissues adjacent to dentin and cementum intact for some time. Indeed, this pathway is more accessible for the production of periapical disease than of general infection of the apex.

(C) The presence of nerves, under these pulp conditions, sufficiently nourished and functional to record pain, denotes a persistent vascularity. The common resistance to arsenic, cocain, and other medicaments, offered by many stages of chronic ulcerating and granulating pulpitides, is hopeful, and indicates activity of nature's usual granulation methods, protecting the apex and contained vessels against infection.

(D) The results of recent research, by Box (3), conclusively demonstrate a complete circulation of tissue fluids, thru the cemental apex from the periodontium via the lacunae and canaliculi, the granular layer of Tomes and dentinal fibrillae, to the apical third of the dental pulp. This condition emphasizes the source from which the cemental matrix of a vital apex, and possibly apical pulp-shreds and vessels, are nourished; for they are thereby in touch with serologic factors, which not only fight infection, but prevent it. It is a most hopeful feature; but, when once this labyrinth is infected, these lines of communication become pathways by which sepsis passes into the apical periodontium, destroying and detaching it, and creating a thoroly septic, necrotic, apex and periapical disease.

(E) There is the further fact that this means of communication cannot be demonstrated in middle-third cementum (3), the first circumferential lamella (lying next to the granular layer of dentin) of which is unorganized, with no connecting canaliculi crossing it from pulp to periodontium. This is, indeed, a protective feature, for, if infection can be prevented from reaching the apical dentocemental communication, a definite barrier exists against it in the middle and gingival thirds. If this were not true, alveolar abscesses would commonly occur beside the root on the middle third, as pararadicular, instead of periapically on the apical third.

What part had infected-canal methods of the past in preventing periapical disease in the 52.5 per cent of teeth that were free from it? And what may we expect of future canal surgery? It has been demonstrated by Brooks and Price (4) that dentin and cementum of experimental "dead" teeth in the laboratory, once thoroly saturated with a known and virulent infection, cannot be sterilized, except by agents destructive of normal tissues. This is even more true of a tooth in situ, many statements to the contrary notwithstanding. If dentinal and apical cementum cannot be sterilized, and canal medication was worse than useless; if, as shown, very few apices have ever been filled, except by leaking fillings; then, all the canal work of this period was useless and all teeth so treated should be periapically diseased—yet this, happily, was not true in 52.5 per cent of the cases.

There is no doubt that the remaining 47.5 per cent were as thoroly saturated with infection as the "dead" test-teeth of Brooks and Price, and that all treatments in these denuded and infected apices, surrounded by infected granulations, were as useless then as we believe them to be now. There is much reason for believing that, in the other 52.5 per cent, a resistance inherent in the tissues, previously described, was so supported by canal medication and pulp-removal methods of the period, that (a) infection and putrefaction were delayed

in subgingival dentin and apical-third pulp-shreds, and that (b) complete apical infection was prevented by germicides placed directly into the pulp tissue, which is quite impossible in deeply infected dentin. Dentin was not sterilized, but apical dentin and cementum were not permitted to become deeply infected by the removal of these much medicated pulps. Infection was thus confined to the middle root-third, with its impermeable cemental laminæ, until the apex and vulnerable apical dento-cemental communication could be filled.

We believe that, by modern modifications of this method, in which greater speed and less radical medication are necessary, many more Class V cases may be saved from ultimate apical disease; hence:

Conclusion 6. For the teeth of Classes I, II, III, IV and V, diagnosed carefully and promptly: "If pulps can be removed under as nearly aseptic conditions as possible, by careful chemico-mechanical instrumentation, leaving only inaccessible vessels and vital pulp-shreds in the immediate foraminal openings of a vital apex, which has not been cauterized nor over sterilized; or, if these strong agents can be used without their passing out into the membrane (tho conservative operators prefer milder medicaments)—if all this can be accomplished without perforation and encapsulation, avoiding infection from debris, then any canal-filling method, as nearly aseptic as can be, that will close these openings well into, but not thru, the apex will insure apices infected as little, and filled as much, as possible and functional teeth" (16).

Any discussion of pulp removal raises the question of its apical boundaries. These are defined according to age. The young apex (papilla stage) presents one large trumpet-shaped foramen, with few cemental laminæ to or thru which the pulp extends. It is next to impossible to remove such pulps or fill the foramen without producing periapical disease. In the adult apex (pulpal stage), which is rounded or pointed, and built entirely of cementum about the main and many accessory vessels, forming multiple foramina (40 per cent occur in all teeth), the pulp proper is only that tissue bounded by odontoblasts, as explained by Grove (17, 18), and the apex contains only vessels.

In all poorly filled, and 38 per cent of well filled, apices these foramina still remain unfilled, because no method, in or out of the mouth, is known for detecting their number or deflected course; and, even if detected, no efficient technic is known which will either safely remove the vessels or fill the foramina. So, the tissue generally removed, except in intentional perforation, which finds or makes, and fills, one opening, neglecting all others, is that bounded by odontoblasts.

"There is some evidence for believing that remaining vessels and apical pulp-shreds, lying in touch with surrounding vascularity, either become organized into fibrous tissue or foramina are closed by deposits of cementum or osteo-dentin" (16). This can occur only in a vital apex, not infected, nor saturated with chemicals, nor perforated and over filled; and only in one to which the periodontium is physiologically attached (27).

The vital apex (13, 14) is, thus, the crux of all canal operations. Its maintenance is worth any amount of time and effort. It cannot be encapsulated because periodontal fibers are everywhere attached to it. There is, therefore, no denudation or hypoplasia in which encapsulations may lie, unless they traumatically protrude into the membrane, granulomata, or cysts. Quite the reverse: the denuded apex, necrotic by whatever means, is not worth a moment's effort, no matter how medicated nor how well filled. One of the gravest mistakes of dentistry is the stubborn belief that correct root-canal filling will cure apical disease. The most perfect canal opera-

tion is never a curative, but only a preventive procedure. It will never cure, and often does not prevent periapical disease. The warning against overmedication too prolonged or too high in oxidizing power, should again be emphasized. "There is more occasion to fear chemical tissue-invasion, than infection, because bodily resistance is better prepared against infection than against chemical necrosis; particularly is this true of connective tissues" (13, 14, 15).

"If none of the known methods really fills apices, in all their ramifications, what has protected the subapical tissues and patient in the defective work of the past and present against infection, or reinfection? . . . . It is daily becoming more evident, to many investigators, that some process other than the dentist's processes, is the final equation in root canal treatment and filling. This factor which fills, and in the past always has filled, or repaired, foramina unfilled, in so-called perfectly filled roots (preventing infection in 52.5 per cent of imperfectly filled roots), is the complicated reparative process common to all body connective tissue, namely, leucocytic function (endothelial leucocytes, etc.) plus good fibrous tissue organized by fibroblasts, cementoblasts, etc. These investigators approve any method that improves apical technic, provided it does not interfere with this reparative function" (16).

All of the foregoing cannot be used by the operator as an excuse for negligent pulp removal, or in expectation that strong medication may be substituted for the finest canal technic—it should stimulate him to even greater effort, that repair may be induced free from infection and without radical medication.

There is an increasing group of radical operators who extract all pulpless teeth because they are infected. They should proceed to the ultimate, and remove all carious and pyorrheal teeth because, as we have shown, they also are infected, if not diseased. The mere presence of bacteria in a connective tissue is not disease, to which dignity it does not rise until certain well known local cell-reactions occur. How are we to distinguish as between the periapically diseased tooth, where this has resulted in the subapical tissues, in touch with the blood stream (Class VI), and the apically well filled pulpless tooth, where it has not occurred (Class V)? The answer lies in correct diagnosis of apical disease, defining the normality of the attaching tissues, namely, cementum, periodontal membrane and alveoli; all equally as important as, if not more than, the pulp.

The laminated cementum is built by and in the fibrous periodontium. Both are developed according to age and use. The laminae and fibers of both respond to every stress thruout life by repair, which is not uncommon even in controlled infection. These are no more important, attaching the tooth, than the dense lining of the alveoli known as the lamina dura, which receives the insertion of the osteal ends of these fibers. If the cells of these tissues lie in physiologic apical contact, attaching a well filled tooth from which the pulp has been removed, that tooth is healthy, no matter whether it be called a "non-vital," "pulpless," or "dead," tooth (26). When this contact is broken, periapical infection exists beyond the tooth and can best be diagnosed by radiographic study, modified by clinical symptoms. "Principal among the clinical bony land-marks stands the character and stability of that hard lining of each alveolar socket known as the lamina dura. . . . . Showing as a dense line surrounding each tooth, uniting with its neighbor to form the interseptal crests, supported by trabeculae, which are important, it defines circumferentially the normal width

of the periodontium. Its disappearance in areas, particularly in middle and apical-thirds, with thickening of the dark line representing the periodontium, indicates undue stress or proliferating periodontitis. It may be completely fused in this region by normal cemental repair, or the hyperplasia may progress to a hypercementosis. It is missing in cemental hypoplasia and denudation, or when the periodontium is destroyed in the midst of suppuration, granulomata, unorganized granulations or cysts. . . . . Lack of continuity in the lamina is undoubtedly a most valuable symptom of infection advancing beyond the tooth; and, clinically, if it be intact, the cementum should be considered healthy" (16).

"The radiograph taken and developed according to the latest technic by those familiar with facial and dental anatomy, in form generally of intra-oral films, sometimes extra-oral plates, is simply indispensable. . . . . Radiographs do not show infection, nor disease, of facial or mandibular bones and soft parts, any more than in other body tissues. They do show, by contrasting radiopacity and radiolucence in two dimensions, in all hard and many soft tissues (as no other method will), destructive, constructive and developmental variations, when compared with normal surrounding tissue (16). Serious pararadicular disease is occasionally masked by roots paralleled or superimposed on the film; but periapical rarefaction, occurring around the apex, is always visible and diagnostic of a dead apex; about which the subapical bone can never form, for it is negatively chemotactile. Bone repair and sclerosis may occasionally present as dense as cortical bone, but the trabeculae and partitions of the adjacent normal bone, to which these should be compared, are missing.

"Sequestra occasionally seem more radiopaque than normal bone and rarefactions may result systemically from osteoporosis, osteomalacia, pregnancy, or calcic waste; in fact, many unusual factors may, but rarely do, appear. . . . . Exceptional cases cannot be compared with the usual, and should not be quoted, disturbing confidence of honest operators seeking help, nor can they be used by dishonest operators seeking an excuse" (16).

There can be no better illustration of the diagnostic accuracy of the radiograph in the radiographic study of all kinds of bones than the striking regularity with which radiographic rarefaction defines apical disease as indeed a strictly periapical and not a pararadicular disease, involving middle-third periodontium. The radiograph demonstrates in thousands of films, the usual infectious portal thru the root-canal, via the apical dento-cemental communication of Box (3), and confirms the importance of this discovery in histopathology as the cause which limits all surrounding granulations, cysts, etc., strictly to this area. The constancy with which this occurs demonstrates the efficiency of the barrier offered against this (the usual) pathway by the impermeable first cemental lamina of the middle-third, with no communication between pulp and periodontium.

"If radiographs can be trusted in abnormal tissue study, they should be trusted to show normal tissue detail and repair; and if there be a defect, it is in showing too little rather than too much tissue involved. No better diagnostic means is at hand. The whole matter hinges on the clinical features, plus the operator's attitude in interpretation, which must never be attempted unless the patient's history and tissue are under direct survey" (16).

With the foregoing diognostic, operative, and reparative possibilities in mind, we deduce the following:

Conclusion 7. If pulp removal and canal filling can be accomplished according to the conditions specified in *Con-*

clusion 6; if the lamina dura is definite, and surrounding bone cancellations appear to be normal, as in adjacent vital teeth; if there are no clinical symptoms and the apex is not hypoplastic, but contains a filling well into, but not thru it, with no visible open canal beyond; then a pulpless tooth so situated should be retained, as it is functional and harmless.

Because of inoperable canals and multiple foramina, the superior molars and canines, and the inferior molars, are occasional exceptions to this rule, which should be kept under survey. If periodontal symptoms arise, the affected teeth should be promptly extracted.

It is true that a percentage of past canal-work, still remaining, is doubtful in quality and should be kept under observation; but there is no justification for suspecting the vital apex, filled by modern methods, except as noted.

It is distinctly not true that apically well-filled teeth of the past, showing no apical disease, are a menace, and should be extracted in the ill patient, or as a diagnostic experiment in one who is under observation, just because periapical disease, even if not demonstrable, *might* sometime result.

Occasional cases are reported of the occurrence of apical disease on well-filled teeth, by hematogenous convey from other focal areas or systemic disease. Similarly, it is said to arise from chronicity or lowered resistance. The writer has observed this frequently in poorly filled, previously diseased, apices, the chronic condition becoming acute; but never except as noted in a well-treated apex. Granted such a possibility, if well filled apices have not as yet been involved in a patient suffering from metastases, toxemia, or the reduced local and general resistance of chronic disease, the chances are that periapical disease will never so result; and such teeth should be retained, for no better test could be had of the apical repair and the success of the operation.

In the writer's experience and from a complete survey of the literature, the investing tissues about very few well filled apices, free from apical disease, have ever been cultured with positive results. Quite the reverse; thousands of laboratory studies prove that all poorly filled and apically diseased teeth are infected or surrounded by both infection and pathology. Hence:

Conclusion 8. General nutrition may be seriously disturbed, and great distress caused the patient, by indiscriminate removal of Class-V (apically well-filled) teeth, for diagnostic purpose or because infection is suspected. Such operations are frequently peremptorily ordered by medical men in their anxiety to cure disease and in ignorance of oral pathology. Obviously, such teeth are extracted by a dentist, who, if he does not protest or refuse, but operates following a fad or thru fear of, or to please, his medical confrere, undoubtedly damages the patient's health and lowers dignity of his profession.

Necessarily there must be a real local pathology in the attaching tissues, a definite disease focus in touch with vascularity, before a general or systemic pathology can result from it. The term "focus" is most happily defined as a "fire-place," and such must really exist before its bacterial content may be raised in virulence, or its cell reactions permit of toxicity and general focal infection. This can and does occur in the improperly treated open canal, where the entire tooth, as well as the surrounding tissue, may well be the "fire-place," but not in a well-filled apex, protected by normal periodontium.

Class VI—Infected teeth; septic pulps

There is little use in consuming time for a consideration of the teeth of Class VI (infected teeth, septic pulp, involved by periapical disease). They have been

much discussed in former papers (12, 13, 14, 15, 16) and are really not worth while, for the reason that no adequate treatment is known which will certainly cure the suppurative, granulating, or cystic, phases of apical disease, except surgery. This statement implies recourse to *(a) apiectomy,* which is rarely successful, because the apical section of dentin and cementum, left by the operation, is not sterile, and generally, if such tissues are sterile, apical disease does not exist, hence there is no need for apiectomy; or *(b) extraction,* which obviously destroys the tooth, but does not cure the bone lesions, except when followed by *(c) curettement,* the third and most important surgical expedient.

A cure of periapical disease may be defined as regeneration of the lamina dura and associated trabeculae, comparable to adjacent areas on vital teeth or other operated areas, following extraction and curettement. It should result promptly (in four months) and the new bone should be deposited to a line the width of other periodontal membranes, in the same mouth, and the tooth must be clinically correct. Such repair is indeed rare. It has been noted occasionally in acute cases, where subapical tissues were sharply infected by acute purulent pulpitis, and were as quickly relieved of exudates by prompt drainage and canal treatment. These cases reverse the rule, which is that of a primary chronic infection, usually followed by an acute secondary parulis or fistulous abscess, associated with a necrotic apex. Any treatment of this latter type seldom succeeds; subapical bone may appear, as if repaired, but soon breaks down, invading a larger area. Hence:

Conclusion 9. With the exceptions mentioned, all periapically diseased teeth, when clinically and radiographically definite (Class VI), should be promptly extracted and sockets curetted. If there be the slightest question, it is best to err radically, and remove a doubtful tooth, than to risk inevitable damage to adjacent teeth, attaching tissues, or the maxillae and possibly the patient's health.

Many medical men, principally pathologists, believe the oral focal infection idea to be much overdone. Others do not subscribe to it at all. Whatever the outcome of this disagreement, we conclude as follows:

Conclusion 10. Dentists generally must surgically remove all such lesions, regardless of whether they be infected or not, because a real chronic bone pathology exists about the tooth and its cell reactions often simulate malignancy—it eventually proliferates, undermining the denture. So, obviously, the dentist, quite as urgently as the physician, and certainly the patient, desire prompt action to prevent further bodily invasion.

The writer is just as confirmed a believer in the doctrine that apically diseased teeth (Class VI) are infective foci, which may cause systemic disease, as he is in the fact that pulpless, apically well-filled, apically healthy teeth (Class V) do not produce systemic disease and should be retained. The relation of these lesions, to the various systemic diseases with which they are associated, has been discussed in previous papers (12, 13, 15).

The assurance of those who so confidently state the modus, by which disturbing elements of oral foci create far distant systemic disease, is disconcerting to any close student of the local oral pathology; by metastases, toxic or allergic processes, these results are said to arise, with little actual proof.

From an entire pyorrhetic denture, undermined and swaying in purulence, to a single locked periapical area walled off by condensing osteitis or sclerosis, nature's best protective procedure, is a far cry in pathology; and yet we know the former may do less systemic harm than the latter; just as the hypertrophic

pus tonsil may not be a focal factor, while the apparently normal tonsil, with its virulent crypt, may be most active.

It is the writer's opinion that granulomata may exist, well walled off for years in the young, despite the large vascularity, with little systemic invasion, until some lowered resistance, toxemia, or other infection elsewhere intervenes. This was noted frequently by the writer in the otherwise healthy young men of the naval station during the war influenza pandemic.

From many specimens and slides studied under these conditions, it is evident that the fibrous and bony protective walls break down about the many vessels with invasion of the surrounding normal bone cancellations, by fan-shaped series of granulating infected peninsulas. The radiograph shows a diffuse, blurred area with a radiolucent centre, and it is this crypt wall, which should be thoroly explored and curetted, for here cultures may be obtained, while centrally, the granuloma is sterile; again you are referred to the confirmatory work of Goadby (9, 10, 11) in war bone wounds.

Occasionally there is a proven metastasis, as in embolic pneumonia or viridans septicemia, but these are rare, we are thankful to say.

More than likely, retention of cells, which are proliferating, in a closed area causes a pressure toxemia, following Charles Mayo's idea. This is conceivably a nonspecific protein sensitization, due to cell activity and waste; or again reinfection, from open septic apices, may produce an acute, or subacute, reaction in old areas constituting a direct specific infection.

The activity of other infective areas or invasions and allergic states, elsewhere in the body, as Duke (33, 34) suggests, constitutes a definite predisposing factor to fresh, or renewed activity of oral infection; the lowered resistance of age and chronicity; direct infection from tonsils, sinuses, or gall-bladder; toxicity from gasto-intestinal stasis and disease, all create a cycle, of which oral disease is an important segment. So complicated is this cycle, that the writer would hesitate in agreeing with Duke (34, 33) that even eighteen per cent of all disease, focally induced, arises from oral infection; for he believes the percentage of primary oral foci much lower; but all the more important, because no case can be considered clear until all mouth areas are blotted out. Quoting from a recent conservative statement by L. F. Barker (1), the following diseases resulting from focal infection, in which oral areas played an important part, may be named.

"Under the locomotor system—infectious arthritis, hypertrophic osteoarthritis, osteomyelitis and myositis and fibrositis. Under the respiratory system—antritis, laryngismus, embolic pneumonia, infected tonsils and pleuritis. Under the circulatory system—endocarditis, pericarditis, myocarditis, cardiac irregularity, arterial hypertension and atherosclerosis and agina pectoris. Under the blood and hematopoietic system—the secondary and primary anaemias, Hodgkins' disease, and general sepsis. Under the digestive system—achylia gastrica and the different forms of gastritis; the possible relationship to gastric and duodenal ulcer, in some cases; also hepatitis and pancreatitis. Under the urogenital system — nephritis, pyelitis, ureteritis, cystitis. Under the nervous system and the eye—peripheral neuritis and neuralgia, neurasthenic states and recurring iritis. Under the endocrine and metabolic systems, the possible relationships of oral sepsis to hyperthyroidism and to under-nutrition."

The writer, from experience in private and hospital practice, heartily endorses the foregoing classification. It might be interesting, in this connection, to state that the results reported by Dr. Barker in clearing up oral focal infection were obtained by radically removing all periapically diseased pulpless teeth (Class

VI) and curetting, when necessary, the adjacent diseased areas; and by leaving all apically well filled pulpless teeth (Class V) not so diseased, in the mouth; further, they have been so obtained in the last seven years, with as many, if not more, recoveries to the credit of this method than to "100% vitality" procedure.

But it must also be noted that all other focal areas, elsewhere in the body, were likewise radically blotted out. Microscopic oral infection was not removed, and other macroscopic bodily foci ignored. Thus, the focal "hobby" was not over-ridden.

The closure of oral infective portals, if attempted at all, should be uncompromising. Only by promptly ruling out all systemic foci will "the fight long continued against a minute but daily toxic invasion be won; and these principles should be applied equally to all who consult us, either sick or well" (15).

The dentist who, without medical assistance of the highest order, attempts to distinguish between the sick and well patient, ignores recent experience of the Medical Advisory Draft Boards, where it required ten specialists, of whom one was a dentist, to diagnose an ambulant man, to say nothing of a sick one. The dentist presumes by a glance and a few routine questions to determine, instantly, matters which might keep hospital laboratories busy for days. We dabble superficially in internal medicine, when we do not know the actual etiology of or sure treatment for a single dental disease.

One says the complement-fixation test for a streptococcus is as definite as a Wassermann test, when we know it is not; and proceeds to treat apical disease, retaining teeth when it is negative, and extracting when it is positive. Others speak vaguely of dyscrasias, diatheses, and susceptibility to streptococcus. Again another assures us that, if the tonsils are normal, the kidneys or heart and all blood counts correct, we may, without looking further, experiment with septic apices. Many criticise the internist for ordering out abscessed teeth, yet few profess actually to cure them; and, withal, none admit that they are internists. The circle of modern group-medicine always centers in the judicial diagnostic-mind of the skilled internist, who surveys the reports of all associated specialists, writes the final diagnosis and dictates the treatment.

The position of modern dentistry in this combination is now assured and is most honorable. We, of all specialists, are deeply interested, and should be most active, in clearing up all the present oral sepsis; and we are doubly interested in its prevention for the future.

If an amount of energy similar to that which is now being expended by many dentists in heralding recovery from systemic disease caused by oral sepsis could be put into the oral hygienic effort or into further research into dental caries and pyorrhea, for instance, we might eventually prevent these diseases and then there would be little oral sepsis to treat. This would be a much more becoming and modest pose; and, furthermore, it would be attending to our own business—in our own field of pathology, of which we know so little.

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A STUDY OF THE TEMPOROMANDIBULAR JOINT WITH SPECIAL REFERENCE TO THE FORM AND ACTION OF THE MASTICATING SURFACES OF THE TEETH [1]

By J. LEON WILLIAMS, D.D.S., L.D.S., New York City

(Read before the National Society of Denture Prosthetists, October 20-24, 1919)

[1]The publication of the following paper has been delayed for more than a year because of Dr. Williams' desire to complete all the experiments which he could devise bearing on the subject and to publish an account of these experiments as a whole. His final experiments were described in a paper read before the National Society of Denture Prosthetists at Boston, August 20, 1920, and published in *The Journal of the National Dental Association for December,* 1920. This last-mentioned paper should be read in connection with the paper herewith presented as the completion of this work.—EDITORIAL NOTE.

IT was twenty years ago last January, that I sent from London to the New York Odontological Society, a paper which was read by the late Dr. Harlan, under the title: "Which Shall It Be, the Empirical or the Scientific Method?"

It was a criticism of the empirical methods which largely prevailed in the practice of dentistry at that time and a plea for a more scientific attitute of mind toward all the problems that we have to face in our professional work. I have used the expression "scientific attitude of mind" because that is really the important thing in any profession. Only a few men are so situated that they can give up any considerable portion of their time to original research work, and thus acquire first-hand knowledge, but all men engaged in such work as ours should be sufficiently well grounded in the fundamentals of science to present a scientific attitude of mind toward all problems brought before them. And this means a mind fully open to the claims of new discoveries, but with sufficient critical knowledge of scientific principles to make an intelligent examination of those claims.

While we have made considerable progress in many directions during the past twenty years the true scientific spirit is still not in evidence as much as it should be. We often see men giving their allegiance to leaders, and in doing so, parting with the judicial and critical spirit and becoming partisan disciples. This criticism applies more or less to all the professions. There should be no partisanship in science.

There have always been two dangers in the presentation of claims of alleged new discoveries. They may be ignored or condemned without sufficient examination, or they may be accepted without critical analysis. In past times, original thinkers and research workers have suffered most from the inertia of conservative authority. But today we often seem a little too ready to accept any new proposition, especially if it is more or less sensational in its claims. Discoveries come so thick and fast in our time that we are in the attitude of mind of expecting something startling about once a week and the scientifically

uncritical seem always ready to throw their hats into the air and shout for the new thing.

For what I have to present I simply ask your unbiased and critical consideration, which means try it out practically before forming conclusions. My investigations on this subject are not yet completed, but a sufficient number of facts of interest have appeared to acquaint you with the result.

But I should like to make my position with reference to the problems considered in this paper so clear that there can be no chance of misunderstanding or misinterpretation. This may not be possible, for I am inclined to agree with a recent writer on metaphysical problems who says: "If there is any fixed natural tendency or bent of the human mind, it is a tendency to misunderstand and misinterpret." Let me say, then, that while I consider the facts presented as fundamental to any system of technic, I am not advocating or attacking any particular system of procedure. I am primarily, trying to make a scientific analysis of a somewhat intricate problem that seems to have more or less baffled quite a number of investigators.

In my investigations I have followed the experimental method as the most purely scientific method. In all of my work during the past thirty or more years I have followed the sound, common-sense advice of one of the great founders of modern science who said: "If you want to know whether a thing is so or not, go and look and see." If one man can see a thing clearly, he should have no trouble in making some other reasonable man see the same thing clearly.

This investigation has been conducted along entirely independent lines as far as I know.[2] If in any particular it should confirm the work of other investigators, that is a positive gain for science. One great weakness in our profession is the lack of confirmation of statements made by those whose work is never repeated.

Two systems of technic in dental prosthesis have been presented to the profession during the past few years. So far as these systems apply to jaw movements the one is founded on the work of Dr. Gysi and the other on that of Dr. Hall. There are differences and contradictions in these two methods of procedure, and while I believe that these differences, so far as they relate to results, are not as great as many suppose, it is not conducive to that unity of action on which real progress depends that antagonisms should continue any longer than is necessary to bring out the whole truth. Evidently when there are antagonisms or differences in theories, somebody is mistaken. Somewhere there are unfounded premises or unwarranted conclusions.

In making the studies of the temporomandibular joint and the movements of the jaw, which I am about to describe I have incidentally had the hope that some hitherto undiscovered facts would appear which would harmonize the apparent contradictions in the two methods of teaching which I have mentioned.[3]

Having approached this problem entirely by the experimental method, I think it will be better to describe my ex-

[2]I did not know until this work was completed that Dr. George S. Monson had reached conclusions very similar to those presented in this paper with reference to the curves of the sphere being the fundamental, ideal curves on which the mandible may move.

[3]Dr. Alfred Gysi, in the very admirable paper on "Studies on the Leverage Problem of the Mandible" which he read on October 6, 1920, before the Faculty of the College of Dental Surgery, Columbia University, New York, said, referring to the two schools of teaching on the subject: "Each has made accurate observations, but each has drawn wrong conclusions." And then, speaking of the results of his own investigation, he adds: "Such a theory stands halfway between the two schools, and, like the peacemaker in all walks of life, is exposed to the attacks of both." I fear that statement exactly represents my position in this attempt to harmonize the conflicting views of Drs. Gysi and Hall.

periments in the order in which they were made.

EXPERIMENT NO. 1

To record, in a horizontal plane, the limits of movement of the lower incisor point with the teeth slightly separated.

A thin, stiff piece of cardboard was cut to the shape of the anterior, three-fourths of my upper arch of teeth. A rim of impression compound was placed on this piece of cardboard and an impression taken, forcing the teeth thru the

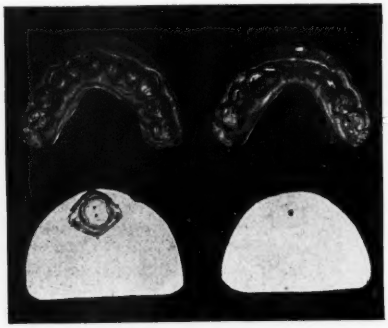


Fig. 1

impression material until they were in contact with the card. After this impression had hardened, it was punctured with a fine-pointed instrument between the upper central incisors on their lingual surface at a point corresponding to the interproximal space of the lower incisors on their cutting edges when the teeth are in their normal position of rest. A similar impression of the lower jaw was taken and a similar puncture made directly over the interproximal space of the lower incisors. A bit of a pencil point was fastened with sticky wax to the lower card exactly over the puncture and an ink dot made over the puncture on the upper card.

These two impression cards were then placed in position on the teeth, the jaws brought together until the pencil point was in contact with the upper card, and the mandible moved in every possible direction. On removing the card it was seen that a complete circle, about 1 cm. in diameter, and also a diamond-shaped parallelogram had been described about the dot on the upper card and that inside these outlines there were lines running in every direction (Figs. 1 and 2).

The significance of the result of that simple experiment is much greater than

Fig. 2

might be thought at first sight. It proves two or three important things: (1) that the mandible has universal movement over an area equal to the diameter of the circle, (2) that the rotation point of the mandible is constantly changing during such movement, and (3) that I can, at will, change the rotation points of my mandible so as to describe a circle and also what Dr. Gysi calls the Gothic arch form of outline. We shall see the full significance of this later, but it is seen at once that the jaw is capable of producing, in the incisal region, *both* of the movements, one or the other of which is claimed respectively by Drs. Hall and Gysi to be the true one.

EXPERIMENT NO. 2

To record in a vertical plane the limits of movement of the mandible with the teeth slightly separated.

This experiment, while not possible with a card fastened to the teeth, is easily made by the aid of an apparatus devised by Dr. Russell W. Tench for another purpose. The photograph explains its action more clearly than can be done by words. Two small plates secured to the molar teeth carry a projecting arm. The end of this projecting arm carries a pencil point turned at right angles to the arm which works on a card held in a vertical position by a frame. It is easily seen that a combination of the opening, closing and backward and forward movements of the mandible will describe a circle on the card (Fig. 3).

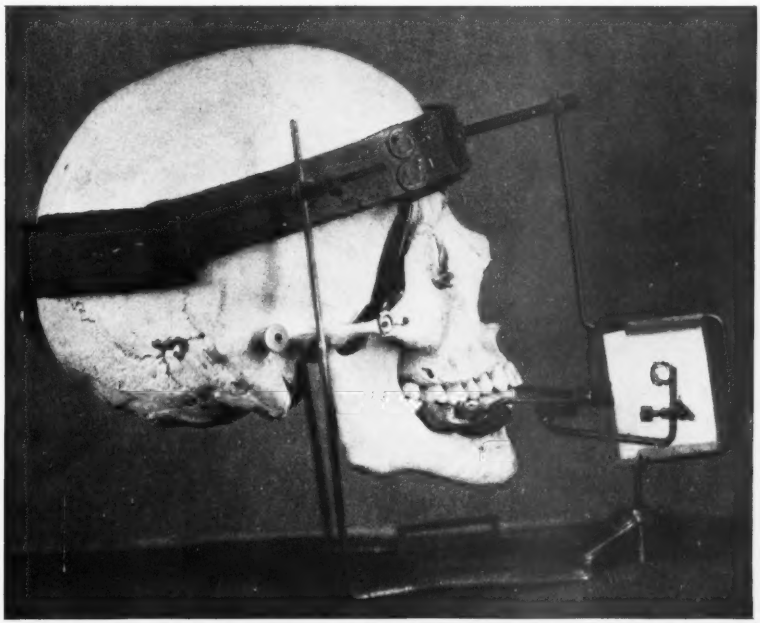


Fig. 3

The combining of these two experiments demonstrates that a point placed between the cutting edges of the lower central incisors could touch any part of the surface of an imaginary sphere, 1 cm. in diameter. The first experiment also shows, as I have intimated, that in order to produce such an effect there must be, not a central rotation *point*, but a central rotation *area* of exactly the same antero-posterior diameter as the circle described.

In addition to the points demonstrated, to which I have called your attention, this experiment also shows that the condyles have greater freedom of movement in the glenoid cavity than has generally been supposed. The position of that central rotation area is between the condyles and its exact location, which undoubtedly varies considerably in different individuals, depends entirely on the extent of the freedom of movement in two directions of the condyles

in their cavities. The greater the backward freedom of movement the more the central rotation area will be brought inward and forward.

The fact that the jaws were slightly farther apart during the experiment described than when in the normal rest-

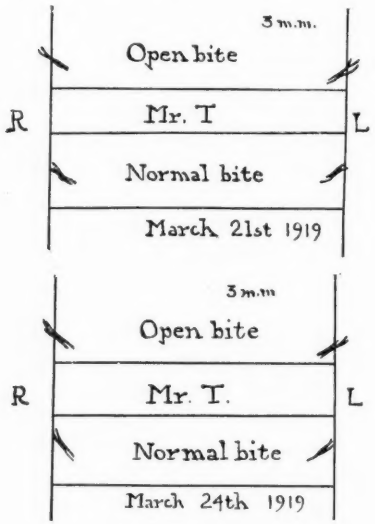


Fig. 4

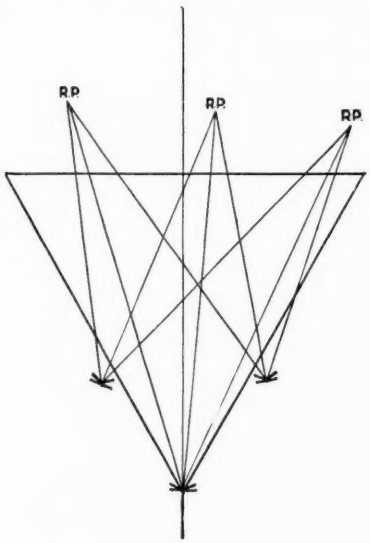


Fig. 5

ing position suggested that this might affect the rotation area of the mandible. A series of experiments with several patients demonstrated that opening the bite does throw the rotation area toward the center.

EXPERIMENT NO. 3

To record the condyle movements of an edentulous patient with a normal bite and the influence upon those movements of slightly opening the bite.

You have two records (Fig. 4), made on different dates, of the condyle path of Mr. T. as made with the Gysi recorder. The lower part of each record, marked "normal bite," was made and a perpendicular line was drawn at the back of the condyle path. The bite was then opened 3 mm., the card placed in position with the pencil point touching the line. The lateral movements were then repeated with the result that there is nearly as much record behind or outside the perpendicular line as there is within it. This means that there was nearly as much backward movement to one condyle as forward movement to the other and that therefore the rotation point with the slightly opened bite was thrown nearly to the center. This experiment was repeated three days later, as you see by the lower record, with the same result. Probably such a record could not be produced with all patients for reasons which will appear later.

EXPERIMENT NO. 4

To record the effects upon the condyle movements of opening the bite for an edentulous patient with condyle movements habitually unlike on the two sides.

This record was made in the mouth of a dentist and the diagram (Fig. 5)

was constructed from this record. The point where the other lines intersect at the back or base of the triangle represent the rotation point at the normal bite. The inner lines, which meet a little at the back of the triangle and slightly to the left of the center, represent the rotation point when the bite was opened. I should say, in passing, that this, and the previously described record, were made with wax bite plates with smooth rims in the usual way. This, as I shall show, does not, or may not, give a true record of jaw movements with the teeth in position. There is a curious circumstance connected with this record which confirms its accuracy. I called Dr. X's attention to the fact that this record in both instances was asymmetrical. Both rotation records are to the left of symmetrical positions. The doctor explained this by saying that during an adventure in Mexico he was struck on the chin with a dagger by a native ruffian. The blow was so powerfully delivered that he was rendered unconscious and from the time of this accident there had been less freedom of movement on one side of the jaw than on the other.

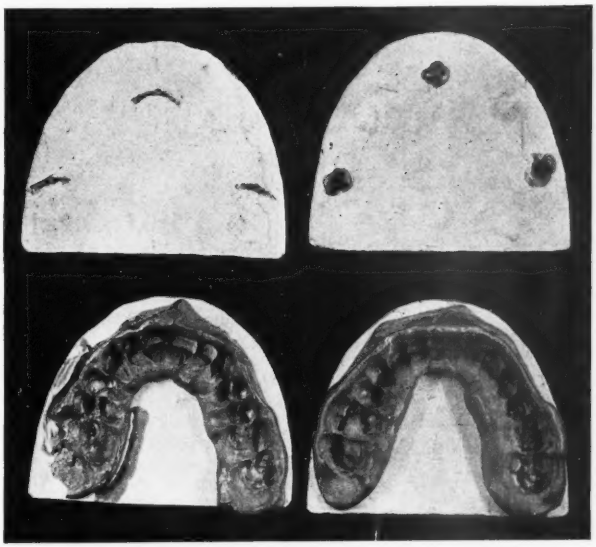


Fig. 6

EXPERIMENT NO. 5

To record, in a horizontal plane, the limits and direction of lateral movement of the incisor and first molar teeth.

This experiment is similar to Experiment No. 1. Impressions are taken on flat pieces of cardboard in the manner already described. A graphite point is placed at the mesial incisal point and two others in the position of the first molars. Close observation of this record shows that circular as well as Gothic arch lines have been described (Fig. 6).

EXPERIMENT NO. 6

To record, in a horizontal plane, the differing movements of the cusps of the upper teeth on the lower teeth with varying rotation points.

The arches and positions of the teeth of a natural skull were drawn to exact

scale on a piece of heavy cardboard. Rotation points were made 7 and 13 mm. from the central point between the condyles. Graphite points were placed in the positions of the upper molars, bicuspids and between the centrals (Fig. 7). The lines and figures inscribed on the diagram of the lower jaw show the paths which the cusps of the upper teeth would

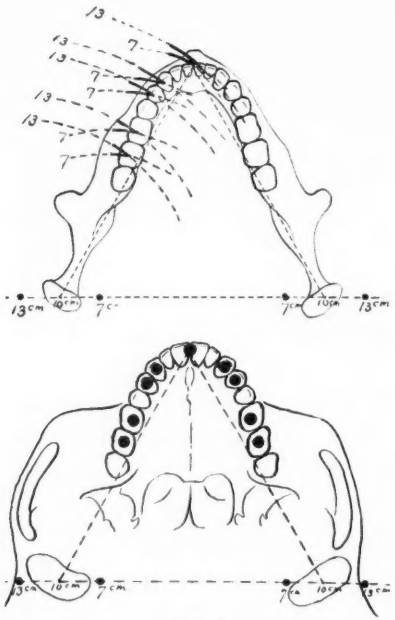


Fig. 7

take if those paths were determined by fixed rotation points dependent upon the relation of the head of the condyle to the glenoid cavity. But are we sure such a condition always exists?

I have used the terms "normal bite" and "open bite" in describing these experiments, but it would be more accurate to say "close-normal" and "open-normal." I believe it is a fact that the Gysi school works with a closer bite than Dr. Hall and his followers. Have we not then in this demonstration one of the harmonizing facts we are in search of? Dr. Hall works with a more open bite than Dr. Gysi and his followers and the rotation point by this method is, therefore, thrown more toward the center.

But there is another important fact with reference to a central rotation point which I think has been entirely overlooked. When there is as much backward as forward movement in the condyles the rotation point is always in the center between the condyles, but the

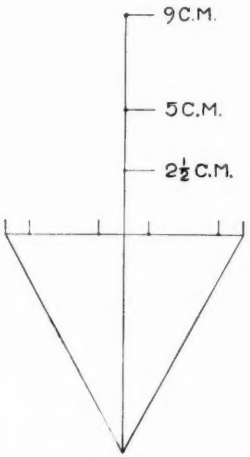


Fig. 8

exact location of any central rotation point in the median line depends, as we shall see, on the amount of lateral or side movement of the condyles. Remembering that one of the very best ways of proving the truth or otherwise of any proposition is to reverse its order, when you can do so, I have prepared a series of diagrams in which I have reversed the usual order of procedure. In practical work you make a record of jaw movements to ascertain where your rotation points are. I have assumed various hypothetical rotation points placing them where the Gysi, Hall and other methods claim to find them and from these rotation points, I

show you what your resulting movements must be in the condyles and in the molar region. The information that we get will probably surprise some of you.

EXPERIMENT NO. 7

To record, diagrammatically, the condyle movement resulting from the location of the rotation point at different places on the inter-condyle line.

Figure 8 shows the Bonwill triangle arranged with seven rotation points—in the condyles, 1 cm. inside the condyles, 1 cm. from the center between the condyles, and in the center between the condyles; also three central positions, 2½, 5 and 9 cm. behind the condyles. Figure 9 shows the rotation points in the condyles or in positions in line with the condyles. There are four of these and all show a lateral movement in the incisal path of 6 mm., which is about the limit of effective movement in mastication.

In the first upper left diagram, in which the rotation points are in the condyles, we have no backward movement of the condyles, but a forward movement of about 4 mm. (I should say that while these figures are not mathematically correct they are approximately accurate.) In the second in which the rotation points are 10 mm. inside the condyles we have a backward movement of 1 mm. and a forward movement of 2.50 mm.

In the fourth diagram, in which the rotation point is in the center, we have a complete range of the condyles of 4.25 mm. in which the backward and forward movements are equal. There is practically no lateral movement of the condyles with any of these rotation points. I wish especially to call your attention to the fact that with all of these four rotation points there is comparatively very little lateral movement in the molar region. This means that the triturating power of the molars would be but little more than with a direct open and shut bite. Such a condition probably rarely exists in any normal case. This difficulty is sur-

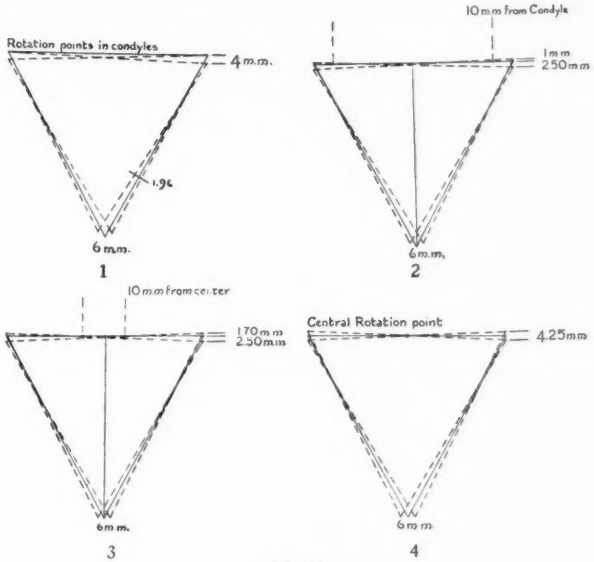


Fig. 9

mounted in a practical way with the Gysi articulator by making much wider than normal excursions in the incisal region to allow approximately correct placing and adjustment of the molars when mounting artificial teeth.

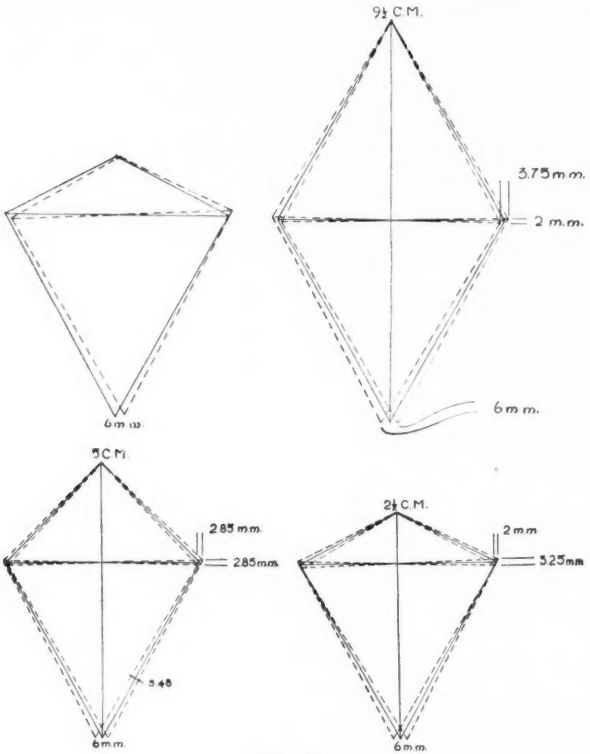


Fig. 10

EXPERIMENT NO. 8

To record diagrammatically the condyle movements which result from the location of the rotation point in the median line at different distances between the condyles.

We have in Figure 10 four diagrams with rotation points 2.50, 5 and 9 cm. behind the condyles and centrally located. The first thing that we observe here is that these rotation points involve *lateral* as well as backward and forward movements of the condyles, and this lateral movement of the condyles, which varies with the position of the rotation point, permits a free lateral movement in the molar region with, naturally, greatly increased grinding force.

Since the original draft of this paper was sent to the gentlemen who are to discuss it, I have made a more careful comparative measurement of movement in the region of the first lower molar with the rotation points in the condyles and in the center 5 cm. behind the condyles. I prepared diagrams of the Bon-

will triangle multiplied by five diameters. I believe it is safe to say that working on this greatly magnified scale I have practically overcome such error as might arise from using diagrams of natural size. Working in this way and then reducing the magnified results to natural dimensions, I find that with the central rotation point and a range of 6 mm. in the incisal path the lateral movement at the distal surface of the first lower molar is 3.48 mm., while with the rotation points in the condyles this lateral movement is only 1.90 mm. With a single lateral swing to the right or to the left this movement would be but one-half of this distance, or .95 mm.

Another striking fact to be seen in these diagrams is that when a central rotation point is from 5 to 9 cm. behind the condyles the backward movement of the condyle is but a very little more than it is when the rotation point is in line with the condyles and 1 cm. from the center. With a fixed central rotation point behind the condyles there must always be lateral movement of the condyles. In order, therefore, to determine whether there is a central rotation point, and just where it is located in any given case, we have only to measure the lateral movement in the incisal path, ascertain if there is lateral movement of the condyles, and if there is the exact measure of that movement in relation to the incisal excursion determines the position of the rotation point. This result can also be reached by comparing the lateral movement in the molar region with that in the incisal region. I have invented a special form of micrometer for taking this measurement (Fig. 11). The suggested possibilities of varying movements in the condylar region, prompted me at once to make a more critical and extended examination of the temporomandibular joint in the skulls of different nationalities.

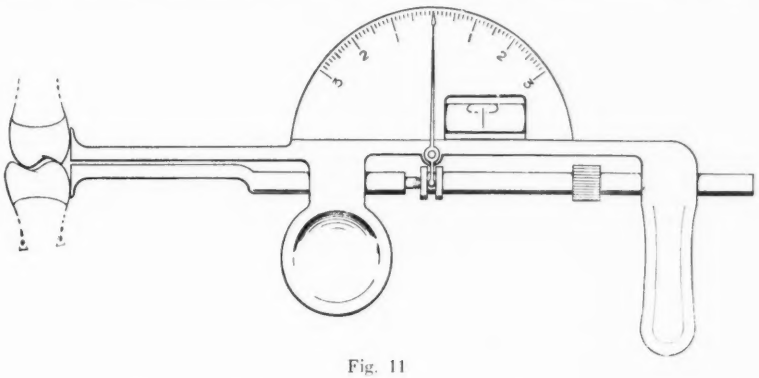


Fig. 11

Experiment No. 9

To determine the relation of the articulating plate to the glenoid fossa in the resting position of the condyle.

The slope of the front of the glenoid cavity, in other words the condyle path, has been studied and measured by many observers, but I do not know of any work dealing with different conditions of the glenoid cavity *with the condyles in position.*

I selected skulls of a number of races in which the dentures were sufficiently good to insure normal resting occlusion. Impression compound was heated, pressed into the cavity and the mandible forced into correct occlusion. After

the impression material had hardened it was removed and sectioned thru the center in the antero-posterior direction.

Figure 12 shows sixteen of these sectional impressions which fairly represent the differences observed. On comparing them we are at once struck by the great variations shown in the spaces between the condyles and the walls of the glenoid cavity. Keeping in mind the fact that a considerable part of this space is occupied by the superior and inferior synovial cavities, we can see how much greater freedom of backward movement of the condyles there was in some of these skulls than in others. Here, then, is one explanation, possibly the complete explanation, of the varying position of rotation areas.

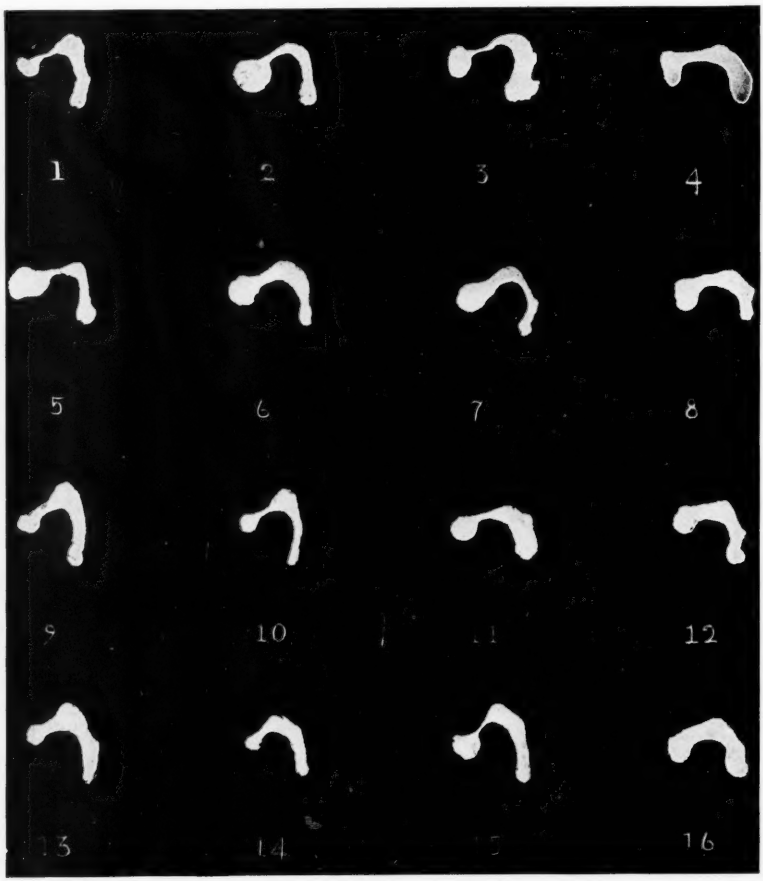


Fig. 12

We saw from our experiments that the greater the backward movement of the condyles the more the rotation area

was thrown forward and toward the center. In the sectional impressions of the Eskimo joints we may conclude that in lateral movements of the mandible the backward movement of the condyle toward which the movement was made

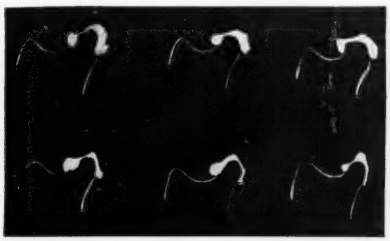


Fig. 13

was about equal to the forward movement of the other side and that consequently the rotation area was in the center on a line between the condyles, or, probably, a little back of the condyles.

Figure 13 shows, at the top, impressions of the joint from three Eskimo skulls. The three at the bottom were especially selected from European skulls to show contrast in the possibility of backward movement of the condyles. But much the same difference in this space may be found in the skulls of mixed races as may be seen from Figure 14.

I have tilted these squlls in photographing them so that you may clearly see the temporomandibular joint with the jaw in its normal resting position. There is more than twice as much space between the head of the condyle and the floor of the glenoid cavity in one case as in the other. This means greater freedom of backward movement of the condyles.

When the conformation of the joint is such as to permit of but little backward movement of the condyles, there must be a greater lateral movement of the con-

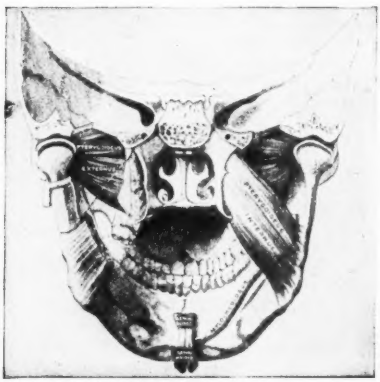
Fig. 14

I understood Dr. Dewey to say that there could be no backward movement of the condyles. That statement may be quite or nearly true in some instances, but it does not apply to many other instances. As a matter of fact, it has been experimentally demonstrated that in certain cases there was nearly or quite as much backward as forward movement of the condyles from the resting position.

dyles if the lateral movement in the molar region is to be maintained. And this, as I have shown, means a central rotation point.

It is evident now that the position of the rotation points or area is entirely governed by the amount of freedom of backward movement combined with lateral movement of the condyles. It seems plain from the conformation of

the upper surface of the condyles and the relation of this surface to the glenoid cavity that any required lateral movement would be forthcoming to meet the demand of the backward movement. In fact it would appear that this must be the case. An examination of the attachments and insertions of the two parts of pterygoid muscles and the consequent logical interpretation of the action of these



Courtesy of Gray's "Anatomy."

Fig. 15

muscles would seem to show that lateral movements of the condyles would usually occur whenever the mandible is swung to the right or to the left.

The external pterygoid extends almost horizontally between the zygomatic fossa and the condyle of the mandible. It arises by two heads—the upper from the inferior surface of the greater wing of the sphenoid and from the pterygoid ridge which separates the zygomatic from the temporal fossa. The fibers pass horizontally *backward and outward*, and are inserted into a depression in front of the neck of the condyle and into the front of the articular disk of the joint.

The internal pterygoid arises from the pterygoid fossa, being attached to the inner surface of the external pterygoid plate and to the grooved surface of the tuberosity of the palate bone and the outer surfaces of the tuberosities of the palate and maxilla; its fibers pass downward, backward and *outward* to be inserted into the lower, back, inner side of the ramus and angle of the mandible as high as the dental foramen.

In one of the dissections which I shall presently mention I had the entire back part of the head removed so as to show the positions of the internal and external pterygoids and so that I could watch the action of the condyles in lateral movement of the mandible. With these dissections I found that it was impossible to make lateral movements of the mandible without producing a certain amount of lateral movement of the condyles. And when we examine this diagrammatic view of these muscles (Fig. 15), as shown in Gray's *Anatomy*, we see that, as a matter of fact, their contraction *must* produce lateral movement of the condyles, for the lateral pull on the condyles must, at least, be equal to the upward and forward pull on the whole mandible. And when we look again at the joint, we see that ample provision has been made for this lateral movement. It therefore seems that from a study of the action of the muscles alone one might safely predicate lateral movement of the condyles.

But Dr. Gysi claims that the rotation points are rarely in the center. Apparently we have here what the metaphysicians call an antinomy, the opposition of one law to another. But in our practical work we are unable to take refuge in Kant's doctrine that a genuine antinomy does not involve any logical fallacy. We *must* have a mechanical explanation of our difficulty. I believe that the following suggestions contain the solution of our problem.

In that extremely small lateral movement which occurs when the planes of the cusps of the teeth are in actual contact (and our whole practical problem of successful prosthodontia is concentrated right there) the mandible often moves on a central rotation point. In those wider

excursions of the mandible, made by the conscious effort of the patient, especially when made on bite plates with smooth rims in which action the movement of the jaws controlled by the cusps of the teeth is not reproduced, the rotation point is forced out of the central position toward the sides. Keeping in mind the first experiment which I described, in which the rotation point was constantly changing during movement of the jaw, we have here a possible explanation of an apparent contradiction.

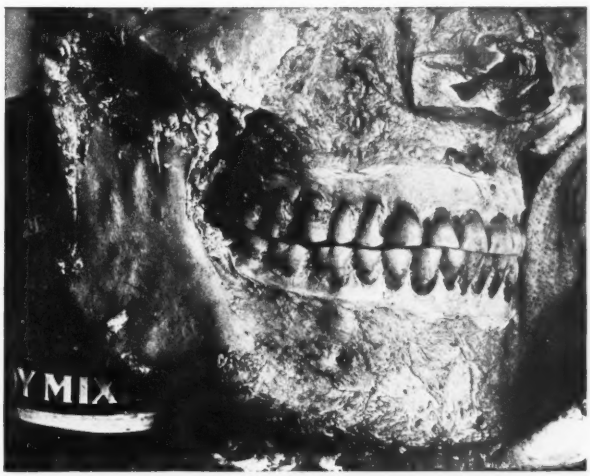


Fig. 16

Let us look just a little more critically at this suggestion to see how it works out. Let us assume that there is, in many or most instances, sufficient freedom of movement of the condyle in the glenoid cavity to permit, during that slight lateral motion involved in the falling and rising of the cusps of the lower masticating teeth on the upper, a sufficient backward movement of the condyle to place the rotation point in the center. That slight movement would, in the majority of instances, bring the posterior surface of the condyle as far back, let us say, as it could go. But, if the pterygoid muscles continue to act and the mandible is forced still farther in its lateral movement, what must happen? Obviously, as the condyle on the rotating side cannot go any farther, or not much farther back, *it* becomes the rotating point for further movement. If the muscular pull can force the condyle a little farther back, then the rotation point will be inside the condyle.

There is just one more point in connection with this phase of our subject to which I wish to call your attention. There are, or may be, two distinct lateral movements of the condyles. One of these would be produced whenever the rotation points were between or behind the condyles. The proof of this I have shown you. But there may be, and undoubtedly often is, an independent lateral movement of the condyles when the entire jaw moves bodily to the right or left. Whenever this action occurs the rotation point is always a movable one.

The Gysi "Simplex" instrument exhibits a very slight movement of this sort but I believe the Hall articulator does not.

In a further effort to get all possible information concerning freedom of movement in the temporomandibular joint I directed the dissection of two heads. All soft tissues were removed from these skulls except the muscles controlling the movements of the mandible. The heads had previously been treated so as to leave the muscular tissues in a relaxed condition. With both of these cases there was not so much backward as forward movement of the mandible from the normal resting position, but there was great freedom of movement in every direction, including lateral movement of the condyles, as I have already mentioned. And there was perfect contact of *all the teeth in* the incisal position (Fig. 16).

The experiments which I have described are only a few out of many which I have made in this study of the temporomandibular joint, and while they throw new and informing side lights on the subject, while they partly explain the differences between the Gysi and Hall systems, they do not completely solve our main problem as to the best possible form and arrangement of the teeth for the most efficient mastication.

Let us try to approach this problem in another way. I have several skulls in my possession which show perfect or nearly perfect occlusion and articulation. In backward, forward and lateral movements all of the teeth remain in contact.

EXPERIMENT NO. 10

To seek out that curve which will insure continuous contact of the upper and lower teeth in articulation.

In studying these skulls one day I asked myself the question, "What is the condition which governs this perfect relation of the teeth in all movements?" In all scientific work the searcher should be ever on the alert for the discovery of a constant or a fundamental principle of wide relationship to which the various facts and suppositions constantly occurring may be brought to a test. This consideration was in my mind when I asked myself the foregoing question. I had determined the radius of the curve of Spee on one of these skulls to be 76 mm. Others showed radii of 77 and 78 mm. (Figs. 17 and 18).

Figs. 17 and 18

In measuring the *lateral* curve across the first lower molars by the aid of special form of protractor it seemed that it agreed closely with the curve of Spee. That being so I saw instantly that the only form on which the lower teeth, for example, could move with perfect contact and freedom in all directions could be a *sphere* the radius of which would be 76 mm. I immediately prepared such a sphere, and removing the coronoid process and front of the rami from the mandible until the arc of a circle was completed from the second molars to the

front of the condyles, I placed the mandible on the sphere and I found, after removing a few imperfections in heights of cusps, that the front of the condyles and all of the bicuspid and molar teeth were touching the sphere on both buccal and lingual cusps, and, naturally, this contact remained perfect with any possible movement of the mandible (Fig. 19). I could place the rotation point in the center of either condyle and make lateral movements in either direction or oscillating or backward and forward movements and always the teeth and condyles remained in contact with the sphere. It was perfectly obvious at once that here was the ideal form-curve to which artificial teeth could be set so as to give the most perfect contact of upper and lower teeth with any possible excursion of the mandible.[4]

Fig. 19

But remembering that in the great majority of mouths of living people and skulls which I had examined such perfect contact in lateral and forward movements of the mandible is not found the second important query "why?" presented itself. The examination of a few skulls in which the molar and bicuspid teeth were thrown out of contact during lateral and forward movements of the jaw showed that there were at least three causes for this displacement: (1) abnormal length or too great backward inclination of the incisal edges of the incisors, (2) abnormal positions of the bicuspids or molars, (3) (and this last cause is the only one which concerns us at the moment) disharmony of the condyle path with the curve of Spee. When by reason of steepness of the front wall of the glenoid cavity, or the prominence

[4]Since this paper was sent to the printer I have heard that Dr. J. W. Needles, of Pueblo, Colorado, has reached conclusions similar to mine by a different experimental method.

of the articular eminence, or lack of sufficient length of development of the molar teeth, the arch of the circle in which the condyle moves is not homocentric or concentric to the curve of Spee, the molar teeth must be thrown out of contact in all forward movements of the mandible. The reason for this is perfectly obvious—the curve on which the condyle is moving is an outward tangent to the curve of Spee. This condition is perfectly illustrated in Figures 20 and 21. Figure 20 shows a skull with the mandible protruded to the incisal bite. The condyle head is in its forward position and *all of the teeth are in contact.* In Figure 21 I have reshaped the articular eminence and made a steeper condyle path. The condyle is now moving on a circle that is outwardly tangential to the perfect curve shown in Figure 20. This new curve is shown by the broken line. The result of this, as we see in the photograph, is to throw all of the posterior teeth out of contact. This disharmony between condyle path and curve of Spee is frequently found in nature.

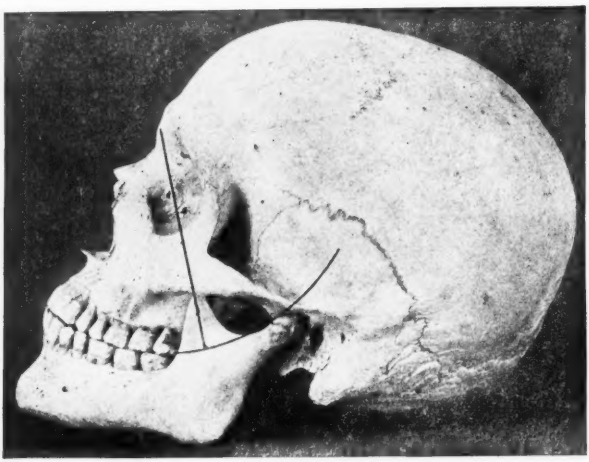


Fig. 20

To correct that condition is to completely solve the whole problem of securing perfect occlusion and articulation of the teeth. There is no other difficulty involved. The consideration of this problem is of equal importance to the orthodontist and the prosthodontist. In my judgment more failures in orthodontia are due to neglect of this point than to any other, but the difficulties before the orthodontist are greater than in the construction of an artificial denture because of the complete freedom of the prosthodontist to place his teeth where he likes.

What, then, is the simplest method of securing harmony of action between the condyles and the masticating surfaces of the teeth? Keeping in mind the fact that it is only in *forward* movement of the mandible, only when the condyle moves down the *too steep* slope of the front of the glenoid cavity toward the eminence that the posterior teeth are thrown out of occlusion, we see that our measurements must be based on the forward position of the condyle, because if

all the teeth are in contact in all forward movements of the mandible they will never be thrown out of contact when the mandible returns to its resting position. The freedom of movement of the condyles in the glenoid cavity to which I have repeatedly called your attention, takes care of all that.

How, then, shall we plot that segment of a sphere for each individual case so that the teeth will have perfect freedom of movement and perfect contact in all normal excursions of the mandible? The first thought that occurs to us is that the center from which the radii are drawn which pass to the cusps of the bicuspids and molars and to the forward portion of the condyles, must be a movable, an adjustable center because we are governed entirely by that forward position of the condyles, and as that is a varying position therefore our radial center must be adjustable. I have devised an apparatus which seems to meet all the required conditions. After the bite plates have been completely worked out to represent length of bite, contour, etc., they are placed in the mouth and the apparatus adjusted. This consists of a stout inelastic band which passes around the head on a level with the eyebrows and is fastened at the back. The front of this band carries a projection which is centered over the center of the nose. To this projection is fastened a hinged arm so adjusted at its upper end that after having made its record on one side of the mouth it can be swung to the opposite side for making its record there. This

Fig. 21

swinging arm consists of two pieces, a central wire sliding in a tube and capable of being adjusted to lengths varying from 60 to 85 mm. The lower end of the swinging arm carries a needle point turned inward toward the mouth.

The first step toward making our record consists in determining the center of the head of the condyles when the mandible is projected to the position of the incisal bite and marking the point of that center with a pencil dot on the cheeks. The jaw is then returned to its normal resting position. A point is now marked on the rim of the lower bite plate in the region which will be occupied by the tip of the cusp of the first

upper bicuspid. The upper movable end of the swinging arm is now adjusted to such a center as will permit the needle point to touch the dot on the cheek and then by swinging it forward to touch the point marked for the cusp of the first upper bicuspid. The cheek is now drawn back and the arc of the circle described with the needle point on the rim of the lower bite plate from the region of the first bicuspid to that of the second molar. This operation is then repeated for the opposite side.

A more simple method, and one applicable to a large majority of cases, is shown in Figures 22 and 23. It consists in placing one point of a machinist's dividers over the spot indicating the position of the head of the condyle in forward movement and the other point in such a position on the headband shown that the point on the condyle head position may be moved to the position of the buccal cusp of the first upper bicuspid without changing the other point on the headband. This is easily effected by

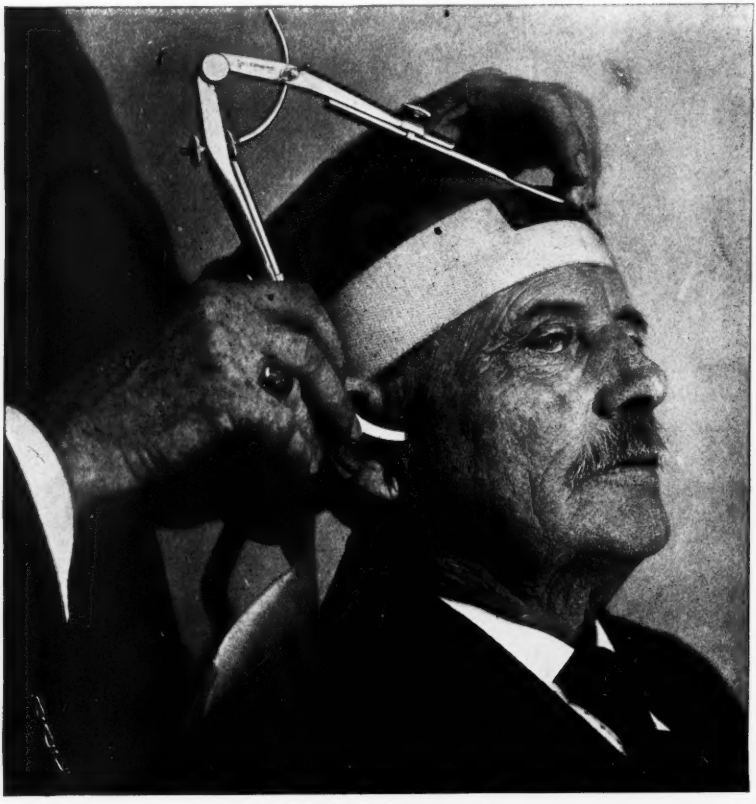


Fig. 22

a few trials, and when the correct position is found, the arc of a circle is described on the wax bite plate. Our record-making outfit also comprises six

Fig. 23

metal plates which represent segments of spheres with radii ranging from 60 to 85 mm. These measurements do not represent the complete range of the radii of the curve of Spee as reported by Nagao, to whose work I shall call your attention a little later. But it is entirely unnecessary to use all of the radii found in nature as they are probably often out of harmony with other conditions in the skull. In fact, it would, perhaps, be possible to use a curve with a single radius in all cases but it would not be as harmonious as curves based broadly on the distance from the root of the nose, or the determined center, to the forward position of the condyle in each individual case.

When the wax bite plates have been arranged in the articulator, the lower plate is removed and that curved metal plate selected the radius of which corresponds most closely with the distance from the root of the nose to the forward position of the condyle. This metal plate is then heated enough to melt the wax of the bite plate (Fig. 24).

By the use of this hot plate, the wax rim of the lower bite plate is melted down exactly to the record made by the swinging arm. Suppose the radius of the curve which harmonizes the forward position of the condyles with the masticating surfaces of the teeth to be 75 mm., which is about the average. Then the segmental plate with the mark 75 mm. will be selected for reducing the rim of the bite plate. This melting of the rim of the bite plate should be very accurately done as it is the most critical feature of the whole operation. When this is accomplished the bite plate is returned to the articulator and the upper teeth set to the special curve established on the lower rim after which the lower teeth are set to the upper. You now see that this device enables us to construct a denture for any given case so that the teeth will have the same perfection of occlusion and articulation demonstrated when I placed the natural mandible on the sphere. Given artificial teeth which have been scientifically made on their masticating surfaces, as we now know how to make them, and it is easily possible by this method to make an artificial denture with occlusion and articulation, the perfection of which is beyond that of the most perfect set of natural teeth ever discovered.

The great significance of this simple method, which makes a record of other jaw movements entirely unnecessary, lies in the fact that the temporomandibular joint plays no critical part in the movements of the mandible after the cusps of the upper and lower teeth have come into contact. The further closing movement is entirely determined by the planes of the cusps of the upper and lower teeth acting on each other. No system of making records of jaw movements has the slightest practical significance from the standpoint of efficient mastication except so far as it applies to the movements of the mandible after the cusps of the upper and lower teeth have come into contact. The reason for this is that there is always sufficient freedom of movement in the joint to allow the cusps of the teeth to guide the jaw to its resting position. If this were not so the natural teeth could never come to a normal resting position unless the action of the condyle in its cavity were perfectly harmonized in each individual case to the masticating forms of the teeth and the curves to which they are fixed. And this is rarely if ever the fact with natural dentures.

I have said that this method provides for *any possible excursion of the mandible.* Do you realize just what that means? It means that perfect contact of the teeth can be maintained in all the normal masticating and incising movements of the jaw on any rotation point between the condyles, in the condyles, outside of the condyles, back of the condyles, or on a constantly changing rotation area. It is therefore equally applicable to the Gysi or the Hall system of technic. It is, within its own sphere of action, one of those fundamental principles of unusual application and it was foreshadowed in the first simple experiment which I described in which universal movement of the mandible was demonstrated. It is the basic curve of occlusion. It should be clearly understood that this basic curve of occlusion demands that the amount of overbite of the upper incisors must always be governed by the length of cusps of the masticating teeth. When, in forward and lateral movements of the mandible, the tips of the cusps of the upper and lower masticating teeth are in contact,

the incisal edges of the front teeth should also be in touch. This undoubtedly represents the ideal condition of overbite and it is the condition found in nearly all primitive peoples and all races in which the teeth are in regularly formed

Fig. 24

arches and the power of mastication is good.

Frank, of Amsterdam, in what Dr. Gysi calls "some wrongly conducted experiments," evidently reached certain conclusions concerning the importance of the radius of the curve of Spee. I do not know in what way he arrived at his conclusions, but according to Dr. Gysi he claimed that there was only one rotation point and that this point lies from 6 to 20 cm. above the teeth on a line with the center of Spee and at the same distance from both condyles. This is the point of the center of the sphere in the demonstration which I have already given. Dr. Gysi proceeds to show that this cannot be the true rotation point. It undoubtedly *is one true* rotation point but *not* the only one. I have shown you that while the mandible may be moving freely in every direction on *that* rotation point it may also, at the same time, be moving on a center placed in the condyles, or outside or inside the condyles. Dr. Gysi's criticism was perfectly sound from the point of view which Frank had presented, but both Frank and Dr. Gysi obviously missed the great significance of the radius of

the curve of Spee regarded as the radius of a *sphere.*

The action of the planes of the cusps of the teeth in governing all lateral movements is also proof that records of jaw movements taken with bite plates with horizontal smooth rims do not represent the actual movements of the mandible when the teeth are in position. Quite a number of experiments were made with bite plates with smooth rims and the experiments repeated with bite plates in

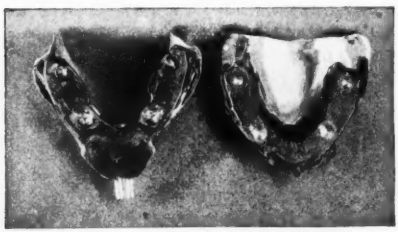


Fig. 25

which grooves or pits had been made on the rims of one bite plate and ridges, or cone-shaped forms, corresponding to the lengths of the cusps of teeth on the other bite plate (Fig. 25). In every one of these experiments the rotation points, as recorded on the Gysi instrument, were nearer the center when the movements were made with bite plates in which the action of the natural teeth was imitated in the manner described. This is precisely what we should expect from the mechanical principles involved. The rocking or oscillating movement produced by the action of the cusps always throws the rotation area toward the center. It is also well to keep in mind the fact that the amount of lateral movement in the mandible which is effective in mastication does not exceed more than about one-third of the bucco-lingual diameter of the bicuspid. In this short movement there is always, as I have shown, the possibility of backward movement in one condyle during forward movement of the other.

There is no ground for the importance claimed for an extended lateral movement of the jaw. But in order to get correct occlusion in artificial dentures an articulator must provide for sufficient lateral movement in the molar region for any given movement in the incisal region. A question may have suggested itself to some of you as to what is to be done in those frequently occurring cases of difference in the condyle paths of the right and left sides. There is no good reason for an articulator adjustment to differing condyle paths, except, perhaps, in those rare instances where the differences are very great, because if the curves to which the teeth are to be set are calculated from that condyle which shows the greatest *outward* tangential departure from the curve of Spee the lesser movement on the opposite side will naturally take care of itself. No one seems to have observed the fact the posterior teeth are never thrown out of contact by lateral or forward movement of the mandible when the condyle path is tangential to the *inside* of the curve of Spee. Here, again, freedom of movement in the joint and the adaptability of the muscles controlling the movements of the jaw takes care of the situation. No patient would ever be conscious that the lesser angle on one side had been adjusted, by the arrangement of the teeth, to the greater angle on the other side. In fact, the harmonizing of the two sides, the setting of the teeth to the segment of a sphere of the correct size, gives the greatest possible freedom and ease of movement. The marked success of the Gysi "Simplex" articulator is entirely due to the fact that its condyle path gives you the greatest forward position of the condyles in a large majority of instances.

I regard these facts to which I have just called your attention as of such primary importance that I shall venture to repeat them in a slightly altered form.

The movements of the mandible are guided by the action of the condyle in the glenoid cavity at all times *when the teeth are not in contact.* But in the construction of artificial dentures we are in no way concerned with those movements. The temporomandibular joint is, of necessity, entirely subordinate to the action of the cusps of the upper and lower teeth when they touch and come into action, and for this reason, the space between the head of the condyle and the floor of the glenoid cavity is filled with tissue and fluid that is more or less compressible. There is no compressibility about the enamel covered cusps of the teeth. In the closing action of the jaw the moment the cusps of the teeth come into contact they assume absolute control of the completion of that action. If any case were discovered in which they did not have absolute control the action in that case would be defective. In the opening movement the moment the cusps of the upper and lower teeth part there is not the slightest interference with any action caused by asymmetry in either or both joints. Of course, in the case of natural teeth this controlling action of the cusps is always more or less perfectly harmonized with the conformation of the point but the coordination which produces that harmony is brought about by the action of the cusps of the teeth as they erupt and come into position. If nature did not make frequent failures that coordination would always exist. The only thing necessary to establish it is, as I have pointed out, to overcome the effect of the outward tangential curve of the condyle path when that condition is found.

There is no articulator of which I have any knowledge that exactly reproduces all of the conditions I have described. The Gysi instrument does not sufficiently provide for the oscillating or slide movement of the condyles altho it does do this to some extent. The Hall articulator does accomplish this with reference to its single rotation point which is probably a fair average, but it has no means for change of rotation point. The Monson articulator has one very valuable feature—the teeth can be set on this instrument to the segment of a sphere but it lacks certain other important features to be found in the Hall and Gysi instruments, especially the incisal pin guide. Our knowledge of the jaw movements has somewhat outrun the mechanical ingenuity of our artic-

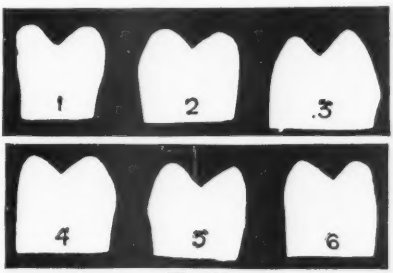


Fig. 26

ulators and we need something better than we possess. We must, however, acknowledge that the capabilities of the best of our articulators are in advance of the skill of most of the men who use them. Nature's power of adjustment, which freedom of movement in the temporomandibular joint provides, and the perseverance of patients counts for more than a little in the measurable degree of success which many artificial dentures exhibit.

The title of my paper would seem to call for some expression of opinion from me as to the comparative merits of deep *versus* shallow "bites" in artificial teeth. I hope I may be allowed to suggest that we have in this subject a very good illustration of what I said at the opening of this paper concerning partisanship in scientific matters. We have had some very arbitrary claims made on both sides of this question. On what are these claims founded? Certainly not on a purely

scientific demonstration for that, in the nature of things is, so far as I can see, quite impossible. We have to depend partly on our own observation and partly on the testimony of patients as to the comparative efficiency of teeth with long or short cusps. The evidence therefore is empirical. But when we have a considerable mass of empirical evidence it may become very convincing.

Obviously, then, the rational thing to do is to set about getting such evidence. It will, in my judgment, require the services of a dozen or twenty of our best specialists, who can affirm that they are unbiased, working for two or three years before we can have a sufficient accumulation of evidence for a sound and final opinion. But this work should be undertaken and it should be done under the auspices of our newly organized prosthetic society. If this is not done the controversy will go on indefinitely and that sort of thing is the greatest hindrance to true progress. Controversies in professional matters always produce bewilderment and scepticism in the public mind. This can nearly always be avoided by organized national procedure.

But while I believe that no one is, at present, entitled to pass an opinion, pro or con, on the merits of this question, I have not the least hesitation in saying, with all the emphasis that I can put into my words, that anyone who is not a master of an exact technic in the construction of artificial dentures will be well advised to leave teeth with deep bites and long cusps to those who know just how to use them.

Technical methods in dental prosthesis are, however, being very rapidly improved and if it should appear in due time that for certain or all cases teeth with deep bites and long cusps are more efficient, then, by the time this question is decided, there will be many more then than are now who will be competent to take up their use.

It should be said here that there is abundant justification in Nature for the use of artificial teeth with angles of cusps and grooves approaching 90°. Figure 26 shows cross-sections of six teeth selected from less than the first twenty models examined from the collection of my son, Dr. Percy Norman Williams. Some of these, 1 and 3, show an angle of 90° and others are near that angle. This evidence does not determine the advisability of making artificial teeth with that angle of cusp and groove, but it shows that the processes of evolution have developed such a tooth.

The set of bicuspids and molars which I have recently carved, with the valuable advice and assistance of Dr. House, and which are being exhibited, have only a moderately deep bite, hardly more than the smallest set in the present Trubyte system. In the hands of expert specialists, I believe they will be found entirely satisfactory.

Teeth with unworn cusps, when the occlusion is right, are certainly the most efficient in mastication. Nature did not design teeth to become worn any more than she designed heads to become bald or eyes to lose the faculty of perfect sight. The wear of the teeth, the loss of the hair and the failing of sight are all evidences of the increasing lack of perfect coordination and balance of the forces and functions of the organism.

In the June issue of *The Journal of Dental Research* there appeared an article by Dr. Masaeu Nagao under the title "Comparative Studies on the Curve of Spee in Mammals with a Discussion of Its Relation to the Fossa Mandibularis." Most of the experiments described in my paper were completed several months before I knew of Dr. Nagao's studies. His paper bears evidence of much careful work. A large amount of data

was accumulated and his conclusions, *as a literal interpretation of the data,* are probably sound.

The only conclusions reached in this paper which concern us at the moment are thus stated by Dr. Nagao: "Spee's opinion, that the path of the lower jaw during its antero-posterior movement is on the curve of Spee, cannot be accepted." He then refers to the proof of this statement which he was brought forward and adds, "I am therefore inclined to believe that the curve of Spee is not closely related, either to the manner of movement of the lower jaw, or to the efficiency of mastication."

The difference between these conclusions and those which I have presented in this paper illustrates, from my point of view, one of the most vital conditions in all scientific investigation having to do with form and function in nature.

For the purpose of the present discussion it does not matter whether we make use of the expression, "Nature's intention," or whether we say "the evolutionary tendency" in our effort to grasp the full significance of form and functional relationship. *What does matter* is our ability to perceive the ideal form and the perfect function as *suggested* by Nature's more or less imperfect achievements. Nature rarely achieves perfection in any direction, but it is or should be the high aim of scientific reasoning and rational art to predicate and portray the perfect from Nature's imperfect suggestions.

Dr. Nagao reaches the conclusion that there is no essential relation between the form of the glenoid cavity and the curve on which the masticating teeth function because the curves rarely coincide in nature. This seems to me a striking instance of a literal interpretation of facts missing the spirit of truth. If Nature had not given us a strong suggestion of this relationship, so strong as to make clear "the evolutionary tendency," who would ever have thought of a way in which that relationship could be so perfectly established as in the demonstration which I have given you? The final and irrefutable proof of perfection of form is found in perfection of function, or when perfect harmony has been established.

In the words of F. C. H. Schiller, professor of logic and metaphysics in Cornell University, "a harmonious fact is as final to action as it is to knowledge."

I have shown you that a very slight correction of an imperfection, which the evolutionary forces in Nature have in most instances not yet quite overcome, gives us the "harmonious fact" which, as Professor Schiller says, is final to action.

When the practical detail involved in this investigation has been carefully worked out we should have a more accurate technic and a similar technic in dental prosthesis.

STUDIES IN ROOT-CANAL STERILIZATION[1]

By JOHN A. MARSHALL, M.S., D.D.S., Ph.D., San Francisco, California

(From the Research Laboratories of the Department of Dentistry, and of the George Williams Hooper Foundation for Medical Research, University of California)

THE following report deals with an inquiry into the differences in histological structure of the organic matrix of the dentin and of the cementum, and constitutes the first part of a report upon the study of root-canal sterilization.

In preparing teeth for class-room work, it was noted that during the decalcification by acid, certain changes occur in the specimens which are not accounted for by the solution of the lime salts. From certain observed peculiarities, it was decided to determine to what extent this decalcification affected the organic portion of the tooth. The original plan of the experiment was to compare a ground section of a tooth with a section made from a decalcified specimen, for such a comparison would demonstrate the differences in the structure of the organic matrix from the structure of the ground section. Most authors agree upon the fact that the deposition of solid, inorganic portions of the tooth is made around the fine fibers of an organic matrix. For example, Noyes (1) states that the organic basis is formed first, and that "the inorganic salts are combined with it in a weak chemical union." Each tissue—enamel, dentin and cementum—is formed within its own matrix in a process which proceeds nearly simultaneously. Also, Mummery (2) and Von Ebner (3) have shown that this network in dentin is composed of a reticulum "of fine fibers of connective tissue, modified by calcification, and when that process is complete, entirely hidden by densely deposited lime salts." Finally, Hopewell-Smith (4) states that these fibers are identical to those found in bone, not only chemically, but also morphologically. He finds it impossible "to determine where the one begins and the other ends." Altho he does not state the fact, it is not unlikely that the author just quoted referred more particularly to the study of calcified, rather than decalcified sections. Experimental procedures to be described demonstrate that a separation between the matrix of the dentin and that of the cementum really occurs, and that definite histological differences exist between the two tissues.

Method of Study

If a fully developed tooth is subjected to the action of dilute acids (nitric acid or hydrochloric acid), a solution of the inorganic material is effected. The residue which remains consists of the individual matrices which preserve the general outline of the tooth. The size, of course, is quite considerably reduced, but the difference between the crown and root portion is readily recognized.

The technic of decalcification, or of the removal of hard portions of teeth, has been developed and described by

[1]Aided by grant from the California State Dental Society, and the San Francisco District Dental Society. Demonstrated before the California State Society, August 3, 1920.

others in some detail. It consists, essentially, in hardening the tissue for twenty-four hours by means of Zenker's fluid, or by 10 per cent formalin dissolved in normal salt solution. The specimens are then washed, and gradually dehydrated in alcohol of varying concentrations (60%, 80%, 95% and absolute). In this treatment it has been

Fig. 1—First stage in the separation of organic matrix of dentin from cementum. The border of the tissue near the gingiva has been loosened, and is rolled back. Figs. 1-6, inclusive, show the macroscopic characteristics of the two matrices.

noted that the usual time of twenty-four hours is insufficient for the thoro penetration into the portion of the tooth lining the pulp chamber, and it is necessary to lengthen this interval to forty-eight hours for each of the different strengths of alcohol used. Unless this is followed, the inner portion of the tooth does not "clear" well in xylol, and subsequent cutting results in mutilation of the tissue. For decalcification the specimen is hydrated by carrying it thru the different concentrations of alcohol from absolute to 60%, and finally washing in water. Decalcification is accomplished by immersing the teeth in a solution containing 1 gram phloroglucinol dissolved in 100 cc. of concentrated nitric acid, and this mixture diluted to 1 liter with a solution of 10 per cent nitric acid. It is advisable to use a relatively large volume of acid as compared with the volume of the tooth, and 150 cc. of the acid solution have been used to decalcify a tooth weighing approximately 2 grams. The temperature of the solution in some instances was raised to 37½° C., but it is preferable to choose a temperature of

Fig. 2—The outer matrix has been loosened to a greater extent.

about 20° C., as, in my experience, less disintegration of the matrix takes place. Altho freshly extracted teeth were used to advantage, in some instances, in the experiments described, teeth which had been extracted for six months, but which had been kept immersed in a mixture of glycerin and water, were decalcified without apparent injury to the matrix.

As a rule, teeth do not decalcify at the same rate of speed. It is, therefore, advisable to examine each specimen carefully at intervals of 12 hours. The decalcification, unless controlled, will eventually cause a disintegration of the organic tissue. To obviate this result, the tooth is removed from the acid and washed carefully in tap water until free

from the re-agent. In my experience, the time of decalcification varies from 4 to 8 weeks, depending upon the size of the tooth, and, also to some extent, upon its age. Recently extracted teeth decalcify at a slightly more rapid rate.

Fig. 3—The cementum matrix has been separated from the dentin at both borders, leaving a portion of the tissue adherent in the middle portion.

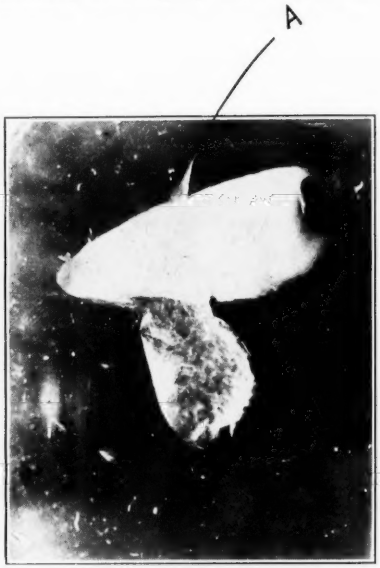


Fig. 4—An enlargement in which the general texture of the organic matrix of the cementum may be observed. A portion of the matrix is still adherent to the tooth as shown at "A".

Fig. 5—The attachment of the outer tunic is severed, and the two tissues are shown in their relative positions.

The Results

The results of this study demonstrate three points:

(1) That the matrix of the dentin may be separated from the cementum.

(2) That the fibers of the dentin matrix run in a different direction from the fibers of the cementum matrix.

(3) That there is a slight difference in the size of the two matrices.

Figures 1 to 6 illustrate the progressive stages which may be followed in the removal of the outer tunic of the cementum from the inner tunic of the dentin. A carefully graduated pressing and pulling motion must be so applied that the direction of the force is toward the apex of the tooth. The ease of the removal depends entirely upon the degree of the decalcification of the specimen. If the process has been of too long duration, or if the acids used have been too strong, or if the temperature has not been controlled, the outer tunic becomes so friable that it breaks readily in the fingers. The matrix of the dentin, also, loses firmness, and fractures upon the slightest pressure. On the other hand, if the decalcification has not proceeded to a sufficient degree,

Fig. 6—The lingual aspect showing the complete separation of the two matrices.

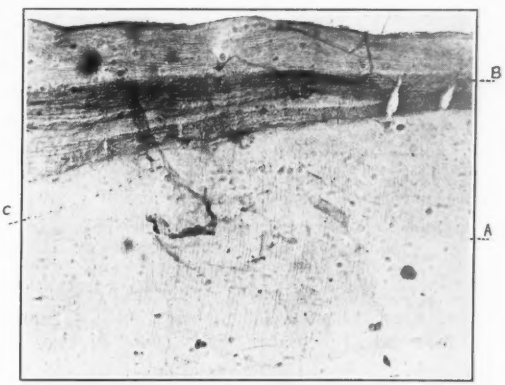


Fig. 7—A section from a decalcified tooth in which the matrix of the cementum is shown attached to that of the dentin. The difference in size of the fibers, as well as their relationship to each other, is shown at "A" and "B." Due to the great friability of the tissues, the section shown contains certain fibers in the field which have broken loose and which have assumed positions abnormal to the rest of the tissues. Such a condition is indicated at "C," the dark line of the fibers having an appearance of a "J." Figs. 7-10, inclusive, show the microscopic characteristics of the two matrices.

the calcium salts still remaining in the specimen make a separation of the two tissues very difficult.

The microscopic study of the tissues shows structural characteristics which are more pronounced in the sections than in the photographs. The illustrations, however, are sufficiently clear to indicate that there is a very marked difference in the relative position of the fibers of the dentin matrix and those of the cementum matrix. In the *dentin*, the direction of the fibers usually appears to emanate from a series of central points. They are analogous to the spokes of a wheel, except that the distance between the fibers does not increase as the fibers proceed from the center. In other words, the fibers parallel each other, and this parallelism is due, apparently, to a complicated anastomosis extending, presumably, from the pulp canal to the periphery of the dentin.

The fibers of the *cementum* present quite a different picture. In this case, they appear to run concentrically around the tooth, and in some sections, are at right angles to each other, as shown in Figure 7.

The difference in size of the fibers is not quite so apparent. The spaces between the fibers are greater, in many instances, in the cementum than in the dentin, and this gives a background on which the cementum fibers appear larger than those of the dentin. This difference in size is not constant, due to the fact that so far it has not been found possible to bring the different specimens to the same stage of decalcification. Consequently, the fine fibrous network is either partially disintegrated, which makes the spaces between the fibers larger, or else, the decalcification has not been entirely completed and a portion of the inorganic material still remains. In the latter event, the spaces are, in some instances,

Fig. 8—A photomicrograph of a longitudinal section of a molar tooth showing location of apical foramen in distal root. The section is 8 mu in thickness. The difference between the cementum matrix and the dentin matrix is clearly indicated, especially in the region of the apex. Further up toward the bifurcation, the cementum matrix becomes so thin that it is hardly distinguishable in the microscopic section.

Fig. 8-A—Enlargement of specimen at "A" showing direction of cementum fibers and dentin fibers.

indistinguishable. The extent to which the fibrous network may be destroyed is shown in Figure 10.

It has not been possible to demonstrate in any of the sections a connection between the fibers of the dentin and the fibers of the cementum. They appear to be entirely different, not only in the direction in which they run, but, also, in their relative size. The fact that no

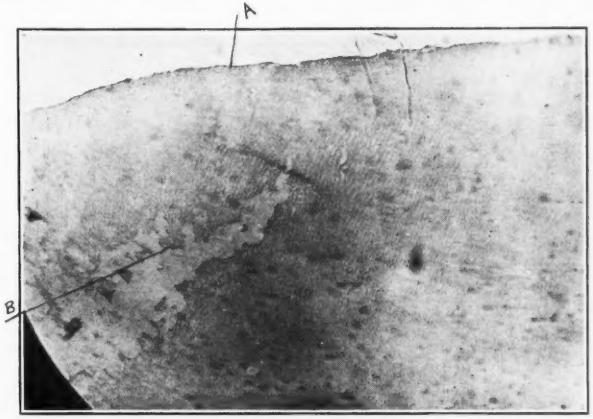


Fig. 9—**A longitudinal section of a dentin matrix from which the cementum matrix has been separated. The dento-cemental junction is indicated at "A". A partial disintegration of the matrix has occurred at "B" where individual fibers have been demonstrated.**

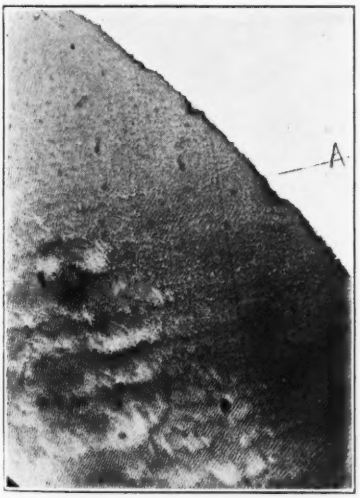


Fig. 9-A—**A decalcified but not disintegrated** dentin matrix. The cementum of the matrix has been separated along the border indicated at **"A"**. Note the **radical** direction of the **fibers thruout the section.**

connection between dentin and cementum exists, has already been demonstrated by Marshall (5) in experiments in which the tissues were stained by means of the vacuum principle. It was shown in these experiments that no connection exists between the ampulae of the dentin found in the Tomes layer and the lacunae of the cementum. This research upon the decalcified specimens would appear to substantiate that already accomplished by the author just quoted.

If the organic matrices of the dentin and cementum are connected, as has been supposed in the past, this connection would absolutely preclude the separation of the two tissues. Communication between the dentin and the cementum would be due to interlacing fibers which would provide channels of communication between the two tissues. Since a separation can be easily accomplished, it follows that the organic matrices of the dentin and of the cemen-

tum may be regarded as two distinct entities histologically different and with the exception of the apical foramen are without channels of communication.

The direct application of this research to root-canal technic and to the problem of sterilizing dentin is to be made the subject of a separate article.

Conclusions

A method is described which demonstrates new facts of histological interest.

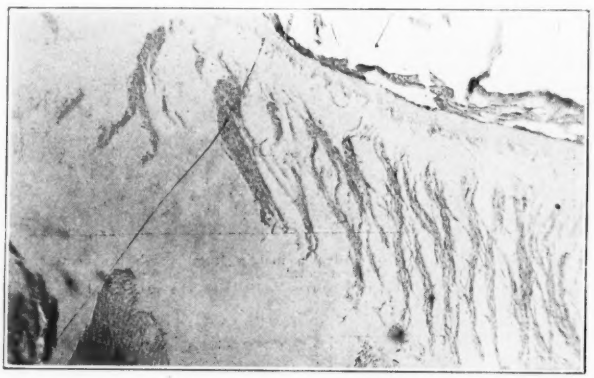


Fig. 10—Longitudinal section of partly disintegrated dentin matrix. The individual fibers may be seen broken away from the tissue.

First of importance is the description of the separation of the organic matrix dentin and cementum. The technic followed in this work is exacting if a clear separation of the two tissues is sought. A macroscopic and microscopic study of the structures so treated indicates that this division of the two matrices would not be possible if any interlacing fibers existed between the dentin and the cementum.

The fibers of the dentin are characteristic in that they are radial in arrangement and those of the cementum are concentric.

In addition to this dissimilarity of arrangement, there is also a slight difference in the size of the fibers. Those of the cementum are larger than those of the dentin. This difference is partly dependent upon the degree of disintegration of the specimen incident to the decalcification. If the process is carried too far, the solution of the inorganic portion of the tooth is followed by a partial disintegration of the organic part. As a result, concordant results are difficult to obtain in specimens which have not been carefully controlled.

I feel very much indebted to Miss R. Carson, Miss V. Litch and Mr. C. O. Tufts for assistance in preparing and photographing the material with which this paper is illustrated.

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CROWN AND BRIDGE-WORK FROM A NEW POINT OF VIEW

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(Read before the Chicago Dental Society, Chicago, Illinois, May 18, 1920, and the National Dental Association, Boston, Massachusetts, August 23-27, 1920)

I

I CANNOT lay claim to having found the whole truth within the realm that constitutes my particular field in dentistry. That would be to acknowledge an absolute rigor and petrification of my conceptions which I am not yet old enough to claim. I shall be more than satisfied, if I succeed only in some small degree in throwing light upon an aspect of crown and bridge-work that has hitherto been very little explored.

II

It is now about thirty years since crown and bridge-work began to be systematically employed as a routine method of replacing lost teeth. While the early records of this operation go back many years, previously the practice was during all that time more or less sporadic. It is not until the year 1889 that I can find any record of its having been taught as a routine procedure or of a definite amount of technic work required of the student. In that year the Baltimore College of Dental Surgery and the College of Dental Surgery of the University of Michigan introduced, for the first time, a technic course in crown and bridge-work. These schools were followed by Harvard University in 1897, and the University of Pennsylvania in 1905. I select these four colleges because they were during these years in the vanguard of dental progress, not only in this country but also in the world. The records of these schools may, therefore, be taken as fairly well decisive of the question as to how long this art has been generally recognized as one of the routine methods of restoring lost dental function. It may remain an open question whether or not the colleges should be held responsible for initiating the standards of the profession; but it cannot be disputed that the college is the most important means we have for perpetuating those standards and the prevailing methods of practice. The different conceptions of restorative dentistry revealed by the prevailing practice in various sections of the country, therefore, constitute a reliable index of the ideals taught and maintained by the colleges serving the various sections and communities. This is a statement which applies with especial force to the eastern and southern states. It is not quite as true of the middle western states. The state board records show that there is a constantly increasing westward migration of eastern graduates, while only a comparatively small number of western graduates apply for a license to practice in the eastern and southern states. These are, in my opinion, significant facts, and facts which many crusading writers tend to overlook.

Besides the colleges, there have been other forces at work to establish standards and to raise the general level of

technical efficiency. These forces have been especially marked in communities favored by the presence of men with outstanding initiative and vision. As examples of what I mean, I may refer to the unusually high standards of workmanship prevailing even in rural communities as a result of the study club work fostered by such men as Dr. Woodbury, of Iowa, and Dr. M. M. House, of Indiana. Above all, the methods employed by that remarkable group of gold foil operators who constituted the membership of the Black Club were founded on true technological principles. They realized there was no royal road to efficiency. They adopted a most severe and exacting method of drill. They were required to be letter perfect in each step of the technic before they were permitted to advance to the next step. They made use of competitive clinics, followed by gruelling critical conferences, in which every member of the club had and exercised the privilege of censure. The only reaction expected of the victim was one of gratitude for the roasting he had to undergo. Perhaps in all this the humbleness that characterizes the true scientific spirit was sometimes forgotten. Many were called, but few were chosen, as I can testify with some feeling, since I was one of those who fell by the wayside. Probably the most substantially useful features of the work of this club was not that the members learned how but that they learned why. The digital dexterity which they exhibited was but an outward expression of the thoroness with which they had grasped the fundamental principles of restorative dentistry. Their motto was an embodiment of the principle that every operation must be so devised as to prevent a recurrence of decay or injury to the soft tissue. This is to recognize what I have often had occasion to emphasize in other connections, that every operation is incomplete or unsuccessful if it does not leave the mouth in the most favorable condition possible. This concept, widely known under the slogan "Extension for prevention," is now generally accepted wherever dentistry is taught.

III

It was not until this fundamental principle was made articulate by Dr. G. V. Black, assisted by a comparatively small group of associates and followers, that the epoch-making advances in modern operative dentistry could take place. These advances have lifted its status from the lowly level of an empirical job of tinkering a little with the teeth to a scientific operation, in which each step taken, from the outlining of the cavity to the polishing of the filling, had set for it a definite end, clearly conceived—the restoration, namely, and the prolonged maintenance of favorable conditions. The clearness with which the operator is able to visualize this end tends to make more and more emphatic the relation which each step bears to every other and to the whole; it necessarily contributes to the definiteness and efficiency with which the operation is performed, and thus makes it possible to carry out the next step with a corresponding efficiency.

The lesson of this example is to reveal the importance of an adequate amount of individual drill and supervision under instructors whose efforts are intensified by being concentrated on one subject alone. Without these forces which I have described, the present status of operative dentistry in the United States could not have been attained; nor could it have been attained without this understanding of the theory of prophylaxis as applied to dentistry. In spite of the comment frequently heard, that the more dentistry one has had placed in his mouth the greater the need for prophylactic treatment, a generalization more facile and humorous than it is true and just, I believe that operative dentistry has been markedly successful in bringing about an improved hygienic condition.

On the other hand, no one will deny that the above humorous generalization, unjust as it is when applied to dentistry generally, does apply with a great measure of truth to a large proportion of our bridge-work. In connection with a subject so frequently discussed, it seems quite unnecessary for me to further debate the shortcomings of which we are all so conscious. But it seems to me important to note one thing in connection with the prevailing discussions of these shortcomings. They are namely, in the great majority of instances, merely a prelude, as it were, to the proposal of some modification or improvement of method, the emphasis being placed almost exclusively upon the mechanical means to be employed, while the basic principles of the work are either ignored or assumed as sufficiently known. And thus it happens only too often, as an inevitable consequence, that the case for a valuable improvement in method is weakened by the inventor's claim of universality of application for his process. Nothing is more irritating, nothing is more retarding to the progress of the profession, than the extravagance and unreliability of the claims that arise whenever a single fact is torn loose from its moorings in the compact body of truth, and made to parade before us as the truth, the whole truth, and nothing but the truth. The champion of such a fact, so paraded, always becomes an expert with an ax to grind, and as such always loses his ability to see and understand other and different facts. The scientific ideal demands a sense of proportion, willingness, nay an eagerness to see all the facts in their proper relations, both those which tell *for* an hypothesis and those which tell *against* it. The scientist is never an advocate, and the lawyer mind with a thesis to prove is as far as possible removed from the scientific mind seeking to know the meaning of the facts in his possession. A method is never an adequate substitute for a principle. The mind that is inadequately equipped with an appreciation of the fundamental concepts of dental prophylaxis will never be able to use even the most perfect of methods in a manner to benefit his patient. A good method is a good road, a means to a certain end which will effectively attain the end. But it is of the first importance to know the end we should attempt to realize, the ultimate end, namely, in its wholeness; and even the best of roads is useless if it lead us not to our destination but away from it.

I would not have you think that I fail to appreciate the wonderful ingenuity displayed in the invention and development of the various methods that constitute the stock in trade of the profession. Nor do I undervalue their importance, or fail to recognize their necessity, if the profession is to realize its aims. And we may justly be proud of the fact that no branch of dentistry can boast of a greater number and variety of technical achievements. But the fact remains that we still have crown and bridge problems on our hands. After having been taught in our dental schools for thirty years, this work still occupies an anomalous position in restorative dentistry. And this statement applies, of course, with special force to fixed bridge-work. What is the meaning and significance of this difficult and embarrassing situation? Is it an improvement of workmanship that is needed or a new method to be invented? Or do we perhaps need to carry both our methods and our workmanship back to a new basis, to give them a new orientation in relation to a clearer and broader grasp of the first principles of all restorative dentistry?

IV

Even the most severe critics of fixed bridge-work sometimes admit that exceptions may be admitted to the universality of the indictment. To quote a paragraph from a recent "Round Table Talk" of Dr. Ottolengui's:

> Is it not possible that much of the failure of bridge-work in the past, and yea, in the

present, is due not so much to faulty principles, but more often due to the fact that the practitioner is either skilful only as a dentist, but unskilful as a technician; or else lacking in operative ability and skilled only in mechanics; or perhaps unskilled in both. * * * * If the truth were known is it not a fact that the men who combine the maximum of ability in the operative field of bridge-work with similar skill as technicians are rare indeed? I pause here to enumerate them mentally. I can call to mind the names of fifteen real crown and bridge-work adepts, and there I am forced to stop and think—fifteen out of the fifty thousand licensed to do the work!

In this comment Dr. Ottolengui has voiced publicly opinions that I have often heard expressed in private conversation—heard, in fact, in every section of the country and in every community I have visited. According to this view, then, fixed bridge-work is not wrong in principle or a failure in the hands of an expert; but it fails because the workmanship of the average dentist, of all, in fact, except a very few, is inadequate to cope with its problems. But as over against this view we must set the obvious fact that the value of any practical art must necessarily be judged by its average results and not by its rare and exceptional achievements.

The letters sent by Dr. Ottolengui to the teachers of crown and bridge-work in our colleges ask certain questions which constitute an invitation to criticize the present status of fixed bridge-work. The manner, however, in which the questions are couched almost invariably suggest the answer expected. That is, the questions are not really questions but rhetorically phrased arguments.

The first question reads: "Were it found that a certain surgical technic resulted in a mortality of 80 or 90 per cent, do you believe that reputable medical schools would continue to advocate such operations?" Two comments are pertinent. The mention of a percentage fixed at 80 or 90 per cent is, of course, merely an emphatic and exaggerated phrase for a very large number, no exact statistics on the questions being available. The word "mortality" has a sufficiently ominous sound, and the whole reference to what reputable medical schools would do in this connection is based on a certain loose ambiguity in its application. As used in the present instance, it means, I take it, the loss of the abutment teeth.

The second question, however, more nearly hits the nail on the head: "Where lies the responsibility? Is it the fault of the practitioner, who lacks the skill to properly construct bridge-work?" I, for my part, believe that the average practitioner practices what he has been taught to practice in college. The average teacher is, of course, only human. But on whose shoulders must the responsibility eventually rest for the next generation of dentists? A succession of unprofitable and possibly injurious experimental variations in methods of procedure are constantly being urged upon him, mostly with great dogmatism of conviction, but with little motivation in an appeal to the first principles. The average dentist is not to be greatly blamed if in this situation he adopts the methods which are chiefly practiced in his region, and which are, therefore, regarded as being safe. I hold no brief for the teachers of crown and bridge-work and am not commissioned to plead their cause or to confess their sins. But I may perhaps be permitted to attempt an answer to this question by reciting my own experiences and revealing my own shortcomings as a teacher of this subject.

V

As I now look back upon my work, I can readily see that my greatest fault in teaching was in the failure to select the right point of view. I followed precedent. I tried to develop in my students the habit of attention to minute details. In carrying out the technic of the work, they were taught to make a bridge that would fill a space. The natural result of this training was that the student saw in every mouth mutilated by the loss of one or more teeth an opportunity to make

a bridge. But this bridge was too often regarded as an end in itself. Instead of seeing the mouth as a whole, instead of seeing the dental arch in relation to the dental functions, instead of seeing the real problem presented by the mutilated arch and its many secondary modifications, the student saw only an empty space which a bridge would close. In other words, he saw only an infinitesimal fraction of the situation, and he could not recognize its most important and essential features. The bearing that the insertion of his bridge might have upon these essential features was, therefore, to him an unknown and unsuspected quantity.

Strikingly similar was the situation in the orthodontic art at the time when the two arches and their relation to the temporomaxillary articulation was not as yet clearly seen or understood as a functioning whole. In this stage of our insight it was not possible to value the individual units in proportion to their contribution to the harmonious action of the whole mechanism. But the subsequent recognition of the true situation, namely the whole functional mechanism, has made possible a classification in the field of orthodontia. It has been the most important single factor in placing this art on a scientific basis. This point of view once accepted, the importance of a thoro understanding of the conditions before attempting their correction, became a logical and natural sequence; and it became generally recognized that the ability to make a correct diagnosis was the key to success in practice.

It is undoubtedly true that the art of crown and bridge-work has problems of its own, whose solutions necessarily require different methods from those of orthodontia. Nevertheless, the ultimate aim must be regarded as the same in both arts, when these arts are regarded from the standpoint of prophylactic measures. Both arts seek the prevention and correction of malocclusion. There is no factor which has a greater influence in maintaining the health not only of the teeth but also of the surrounding tissues than the presence of normal occlusion. The orthodontist has never allowed himself to lose sight of this fact. While dealing with other important problems, such as alignment, bone growth, facial contour and so forth, he has never allowed himself to forget that his chief aim is to secure normal occlusion. Not the least of the many advantages which the steady recognition of this ideal has afforded is the successful standardization of method within the field. As new methods are from time to time proposed and modifications of old methods suggested, they can be and are brought to the tribunal and test of this ideal and accepted or disregarded according as they are judged to contribute more or less effectively to its realization. Mechanical ingenuity has not suffered by the application of this rule; on the contrary, it has been guided into effective channels by the presence and recognition of a fundamental principle. The device has been recognized for what it really is, namely, the means to an end.

The failure to impress this point of view forcibly upon my students was, I believe, the most serious and fundamental fault of my early teaching. The problem here visualized is distinctly not one of appliances. It is a problem of proper conception, of a proper point of view for judging both appliances and methods, and workmanship. It is the problem of holding firmly in mind the ultimate aim and purpose of the work to be done, and of appreciating this aim in as concrete and intelligent a manner as is possible with the knowledge at our command. When we come to grasp this aim more and more concretely, we shall soon realize that we need some accurate method for studying the changes that take place in the arch following the loss of one or more teeth. We need, in other words, to know the difficulties we have to overcome, the threatened changes to be prevented, the abnormal condition

to be, if possible, corrected, before we can decide upon what appliances to use. In the voluminous literature devoted to crown and bridge-work, the study of the unfavorable conditions present and threatened when bridge-work is indicated has been almost entirely neglected. This subject has led to the setting up of classifications both in operative dentistry and in orthodontia. But I am free to say that in no field of restorative dentistry is there presented so great a variety of unfavorable conditions as in the class of cases involving mutilated arch, where we usually attempt restoration with some form of bridge-work. And yet our diagnosis rarely takes these unfavorable conditions into account in any thorogoing manner. We usually confine ourselves to figuring out how we may best apply our favorite form of bridge. We have indeed adopted the practice of making study models; but they fail to have the significance for us that they ought to have, because we lack the comprehensive classification which guides the orthodontist in his interpretation of similar models. We have adopted a method from the orthodontist, but we have not been able to extract from it its full connotative value. We still use it blindly rather than seeingly.

VI

In common with other dental colleges, ours has adopted the practice of requiring the student to make study models before beginning a practical case. As a consequence of this practice, and by the added use of my own private collection, I have had access to upward of eight hundred models. In studying these I have attempted a sort of preliminary sorting-out process. First, I have selected those models which show the loss of the same teeth, and which have, therefore, resulted in the same general type of malocclusion or of traumatic occlusion. I think you will agree with me that if the study should show that the loss of the same teeth generally results in a similar change in occlusion, then it would not prove difficult to establish a system of general rules for treatment. The exceptions could be dealt with effectively when the typical cases are properly disposed of. This work has been delayed, owing to my continued ill health during the last two years, and I am not sure but that the delay has saved me some embarrassment. For while the work has had a certain suggestive value to me personally, I am commencing to see that the kind of classification that I had in mind when I first began the study is perhaps not the kind of classification that we primarily need as an aid to our diagnosis.

What we ought to aim at is less the ascertainment of resemblances and differences than the recognition of likenesses hidden under apparent divergences; particular rules seem at first discordant, but looking more closely we see, in general, that they resemble each other—different as to matter, they are alike as to form, as to the order of their parts. When we look at them with this bias, we shall see them enlarge and tend to embrace everything and this is what makes the value of certain facts which come to complete an assemblage and to show that it is the faithful image of other known assemblages.

Several interesting problems have presented themselves during the study of the models.

First, I wish to express a conviction that has slowly forced itself upon me. Assuming that the occlusion of the teeth is initially normal, and assuming that the shape of the arch is essentially the same in the cases compared, then it seems to me evident that the changes which take place from the loss of one tooth are fundamentally similar. The apparent differences will on closer study be found to be only differences in degree, differences in the intensity of the operation of the same tendencies, these quantitative differences depending upon such things as the age of the patient, the length of time the tooth has been extracted, habit,

the bone growth, and so forth. A single example will serve to illustrate my meaning.

Take the changes which take place following the loss of the first lower molar. These invariably follow a mesio-lingual tipping of the second and third molars—no other change is possible. The shearing action of the opposing buccal cusps prevents a buccal tipping and the ramus prevents a distal tipping. This change in the direction of the occlusal surface of the lower molars forces a buccal rotation of the opposing upper molars, the trituration function on that side of the arch is lost, likewise the shearing action of the buccal cusps is destroyed.

The second bicuspid is also forced to tip in the line of least resistance. The tooth in the upper jaw opposite to the space left by the extracted tooth rotates buccally, giving the lingual cusp an elongated appearance. The buccal lingual planes of the occlusal surface, as well as the so-called curve of Spee, are thus thrown out of harmony with the opposite side of the arch. Mastication of food on the defective side of the arch is in consequence of these changes limited to a punching action. The excessive work thrown on the opposite side of the arch frequently wears down the buccal cusps of the lower molars and the lingual cusps of the upper molars, reversing the occlusal planes and closing the bite. The closing of the bite results in a backward thrust of the lower jaw. In this connection there has been pointed out by Dr. George Monson a very interesting possibility. The condyle of the lower jaw lies immediately in front of the external auditory meatus, so that any backward movement must tend to lesson the diameter of this canal. In some instances, as Dr. Monson has demonstrated to the dentists of St. Paul, this backward thrust has actually succeeded in producing a change in the direction of the canal. He is convinced that many cases of deafness and defective hearing may find their explanation in this fact of the closing of the bite. But to continue the clinical picture. The closing of the bite may result in forcing an overjet of the anterior teeth. While the entire series of events here described may not always result from the loss of a single tooth, some of the changes are sure to take place and frequently all of them. More or less pathology of the supporting tissues also results, as a consequence of traumatic occlusion. Here then we have an exceedingly complex series of unfavorable conditions attendant upon the loss of the first lower molar. And yet we have been taught to regard this as an exceedingly simple case, where nothing is indicated beside some sort of a bridge which will close the empty space due to the loss of the molar.

VII

The lesson of the foregoing analysis is the fact that our vision has been and still is too much limited. Our horizon has not been sufficiently extended for us even to be able to settle satisfactorily the details of technic. The vital, all-absorbing problem of the present hour is to determine whether we should use a fixed bridge, a removable bridge, or a movable removable bridge. These are important details. But it must not be forgotten that they are details. The real problem, however, that confronts the dental profession is the determination of to what extent the disturbance of the geometrical balance in the clinical picture just drawn should be restored. Should we take it upon ourselves to consider the jaw as a mechanical whole, which it surely is, and in consequence attempt the restoration of a normal geometrical balance of its parts? In that case, the filling of the empty space by means of a bridge becomes a subordinate detail. This operation would require the bringing of the mandible back to its former position by opening the bite; it would necessitate restoring the occlusal planes not only on the mutilated side of the arch but on the opposite side as well. Or should we

confine ourselves to the more limited aim of restoring only the mutilated side so as to make it harmonize with the rest of the arch, to restore the function of mastication, and to prevent further movement of the teeth? Even with this limited aim we would have to grind the elongated teeth of the upper jaw, in order to obtain a clearance during the lateral movements of the mandible, which would also involve a restoration of the occlusal planes of the tipped teeth.

Or should we, in opposition to any attempt to broaden the scope of the problem presented, recognize it as good practice to insert a bridge that merely fills the space as it is, thus ignoring the fact that we are dealing with a masticating mechanism which functions as a whole, focusing our vision on the individual unit in question, or regarding as included in our problem at the most only a single segment of one arch?

The case described is that of the most frequent clinical pictures and at the same time one of the simplest for the crown and bridge worker. It involves a choice between three radically different goals. The solution of this problem is far more important and far more fundamental than the question of what method we should adopt. Indeed, when we have solved the question of aim, we may have gone far also to settle the question of method; while on the other hand a discussion of method may turn out to be wholly futile as long as the ultimate purpose is not determined.

If the tone of the present discussion of methods in our journals is a safe criterion, we may perhaps conclude that the question has been settled in favor of the narrower problem and the more immediate aim. At any rate, any other aim seems to be excluded, at least tacitly, judging by the character of the methods chiefly exploited and most frequently regarded as modern. There is suggested for example, a pontac, supported by two clasps, with some emphasis on its special application to those spaces where the teeth to be used as piers are badly tipped. I can readily understand how such an apparatus can be made to fill the space, if that is the problem to be solved; but I cannot understand how it can be used to restore normal function, either on the teeth that have been tipped out of alignment or on the pontac itself. Again, the so-called movable removable bridge makes no attempt to restore the occlusal planes of the teeth. The feature of this appliance which commends it to our acceptance is simply the detail that it allows an individual movement of its several units. How this type of bridge subserves other needs of the situation for which it is claimed to be indicated does not as yet appear. I have no practical knowledge of this type of bridge, and therefore hesitate to express an opinion. But it is my impression that further proof should be furnished to support the pretentious claims made by its author, before the profession can justly be called upon to abandon in its favor many at least apparently valuable methods. Extended experience has served to give me a realizing sense of the many important factors that are involved in the successful application of bridge-work, and it is difficult for me not to feel that the one factor of mobility can easily be overemphasized, with the inevitable result of producing the dangerous illusion that the whole problem is simple enough to be solved by a single formula, a formula, too, that perhaps deals only with the most superficial aspect of the situation.

VIII

Permit me once more to emphasize the changes that take place when a tooth is lost from the arch. There are changes in the opposing teeth and in the occlusal planes, destroying the harmony with the planes of the remaining natural teeth. These changes are sometimes so slight as to be overlooked when examining the mouth itself or even a cast of the mouth. I believe that fixed bridge-work has its place in restoring many conditions

characteristic of the mutilated arch, but we must of course recognize the fact that the teeth used as abutments are more rigidly supported than formerly, that additional stress is being placed on them, and that therefore it is absolutely necessary that our occlusal reconstruction shall be without flaw. And if we are to restore the lost geometrical balance of the two arches by means of bridge-work we need for a successful operation something more accurate as a measuring instrument than the human eye. Every real mechanic recognizes his limitations in this respect and knows that the calipers and the square are necessary to accurate work.

When the changes in occlusal balance are ignored (and I mean here to include every slightest distortion of the occlusal planes, as well as the dropping or elongation of the opposing teeth) and when the bridge is simply made to occlude in a state of rest, then it is inevitable that the range of occlusion should prove to be faulty. In that case it is self-evident that less harm will be caused to the abutment teeth, as well as to the opposing teeth, if both the abutments and the pontac be allowed individual movement. In fact, I am almost tempted to say in this case that the more movement the better, whatever type of bridge-work we may select. In view of our present knowledge of the effect of traumatic occlusion, we cannot ignore our present knowledge of the effect of traumatic occlusion, we cannot ignore our responsibility for the pathological sequence if bridge-work is to be employed as a means of restoring lost dental function. The present rule-of-thumb methods will need to be replaced by methods which will permit the employment of mathematical accuracy.

The principle recently advanced by Dr. George Monson is based on many years' study of the various phases of the occlusion of the natural teeth with the end in view of ascertaining the mechanistic basis which determines the line of stress and permits a clearance during the various ranges of occlusion. He adopts the premise that the normal jaw is one which has a geometrical balance in proportion, building on the Bonwill triangle of which he makes practical use in the development of his theory, that the equilateral triangle of four inches from condyle to condyle and from condyle to

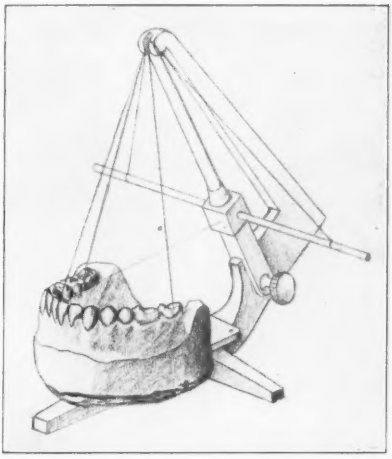

Fig. 1

mesio-incisal angle of the lower central incisors, recognizing of course that the jaw is not always equal in its development. We may have all seven triangles represented, from the equilateral to the isosceles triangle.

Using the Bonwill dimensions as a base, he adds another geometric basis of calculation which he claims may be depended upon in determining the occlusal surfaces of the teeth in relation to the condyle movement (Fig. 1):

The basis of this figure is a sphere whose radius is approximately four inches. The center is equidistant from the occlusal surface of the teeth and the center of the condyle has the same radical dimensions. The occlud-

ing surface of every tooth in the normal jaw will be found to be tangent to the radial line of the long axis of each tooth. In the mandible, where the teeth and condyles conform to the equilateral triangle or approximate these measurements, the best lines of force can be applied to the teeth in occlusion, i.e., the long axis of the lower teeth more nearly approach the long axis of the upper teeth, thus making the direct strain in the line of greatest resistance (Fig. 2). If we consider the buccal cusps of the upper teeth continuous with the overbite, whose function is principally a shearing action, and the lingual cusps of the same teeth as the crushing seat upon which the greatest amount of work is placed, we can readily see why the lingual cusps of these teeth are worn off. The reverse is true of the teeth in the mandible; the buccal cusps are the ones that wear reversing the line of the occlusal surface to the long axis of the tooth, changing the line of force on the occlusal surface, throwing the mandible out of balance in relation to the superior maxillary, producing malocclusion and a faulty relation of the bones, with its attendant consequences (Fig. 3). In the normal jaw the occlusion of the teeth conforms to the surface of the sphere of eight inches in diameter, whose center is the radial point. A line drawn from the center obviously must pass thru the long axis of each tooth.

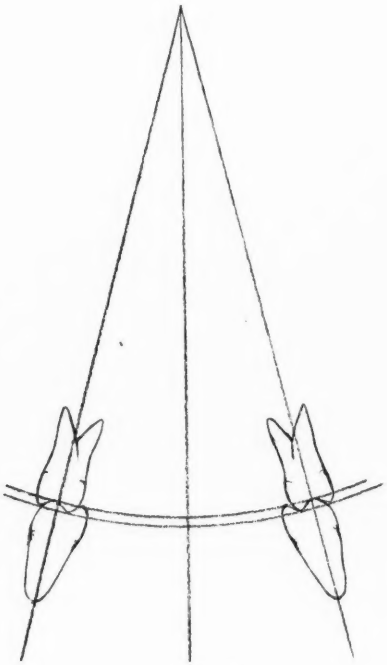

Fig. 2

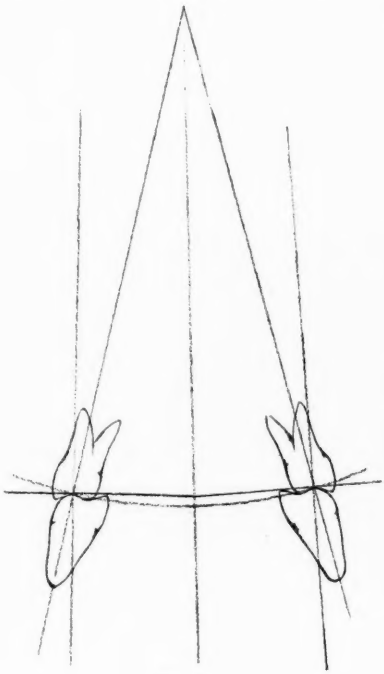

Fig. 3

This is illustrated by the front view of the mandible applied to the sphere (Figs. 4, 5, 6). This extremely sketchy description of Dr. Monson's principle is intended merely as an example of an engineering basis we might employ in studying our models to determine the exact amount of reduction necessary on those teeth which may be elongated and the amount of restoring necessary on those teeth that have been in excessive function, and determining the amount

of occlusal restoration necessary to conform to the surface of a sphere with a proper relation of the cusps necessary to maintain them in proper alignment. The same principles may of course be applied with architectural exactness in the constructions of our crowns and bridges in determining the best clearance or freedom in the range of occlusion.

It is not interesting to have far-away visions, but it is interesting to have nearby visions of what it is possible to accomplish. It is my belief that if these principles could be translated into practice, we would answer the challenge that has been brought to the subject. We would view the art of crown and bridge-work, its teaching and its application, with a new light in our eyes.

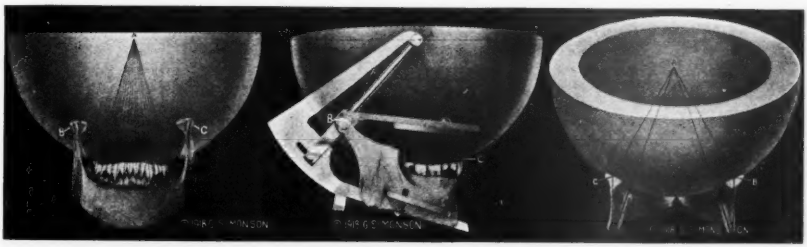

Fig. 4 Fig. 5 Fig. 6

Discussion

Hart J. Goslee: Dr. Orton brings to you some very clear, concise thoughts pertaining to the teaching of this specialty of crown and bridge-work. It is true, as he says, that this specialty is in a somewhat chaotic condition in the minds of some members of the profession at present. However, as I took occasion to say some time since, I am not at all alarmed about this. Crown and bridge-work has been practiced as a specialty for some twenty years or more, and, as Dr. Orton has said, a constant advancement has been made. We are not retrogressing but progressing all the time, and I am confident that our practices of today are better than were those of a few years ago, even tho some of us do not confine our efforts exclusively to the construction of removable crowns and bridges. There is a place in dentistry for "fixed" crown and bridge-work, and its application and usefulness is a matter of mechanical judgment on the part of the operator more than a question as to which method or system should be used. In my mind there is no one method which is universally applicable to the replacement of teeth missing in the human mouth. The greatest fallacy possible to imagine is that any one man's method can be used anywhere and should be used to the exclusion of all others. No one can hope to meet with universal success who confines himself to the use of but one line of procedure in whatever he does, I do not care what it is, and so to this extent I agree with the statements of Dr. Orton and am glad to find that Dr. Ward, of Ann Arbor, and a few others agree with me.

However, the propaganda started by Dr. Ottolengui and carried on by a few others, in which a more or less vigorous condemnation of fixed bridge-work is being made, will accomplish good. There is no question but that all of us were putting on entirely too many fixed bridges in years gone by, and no question but that this practice has been the direct cause of the loss of a multitude of good teeth because of the indiscriminated application of fixed bridges. But if this is true, and I am ready to grant that it is, should we condemn the principle of fixed bridge-work? Not at all, and I say again and with all of the emphasis at my command that I am confident that there will always be a place in dentistry for fixed bridge-work.

While on this subject let me call to your mind the claims made by the devotees of removable bridge-work as a means of supporting their theories. The principal claim made by them is that an irreparable injury is done to any tooth which is called upon or required to support a fixed bridge because of the immobilization or partial immobilization of that tooth, and that this results in a diminishing functional activity and in the ultimate destruction of the peridental tissues. I am not

prepared to agree with such a claim at all, and my clinical experience bears me out.

Dr. Orton has called to our attention one feature which has to do with much injury, possible looseness, and perhaps subsequent loss, of such teeth as are used to support fixed bridges, and that is faulty occlusion, an occlusion which does not restore as nearly as possible the normal functional activity of all teeth so used. And the next feature which I think has more to do with the loss of such teeth than does occlusion is that of leverage, and I believe a greater number of teeth has been lost because of undue leverage, because of exacting or requiring of those supporting teeth an undue and unreasonable amount of work than for any other one single reason, and therein lies the source of failure of most fixed bridge-work, and especially of the larger fixtures. Until the propaganda started by these friends of ours was begun it was not uncommon to see "fixed" bridges of any and all sizes, and a masterpiece was a fourteen-tooth bridge—the larger the fixture the greater the masterpiece. This, however, is just the opposite from the truth, because the amount of stress imposed upon those supporting teeth and the amount of immobilization produced in the application of the fixture increases in accordance with the number of teeth involved. I therefore do not believe in extensive fixed bridge-work, and am happy to say I never have been a believer in the indiscriminate use of this class of work, but I am not going to condemn as useless, or malpractice, the application of fixed bridge-work built upon sound principles and applied with the judgment of a mechanic. I do not think the time will ever come when anyone can say that such fixed bridges are a menace to the mouths or health of our patients. There is and always will be a place for fixed bridge-work, but the largest proportion of successes will obtain from the smaller bridges, because in addition to less stress small fixtures also offer greater opportunity for sanitation. And in all of our bridge-work or in all methods of supplying lost teeth, whether by partial denture, removable or fixed bridges, we must never lose sight of the fact that opportunity must present for keeping the fixture just as clean as the natural teeth themselves may be kept, and if the operator who does this work has this signal thought in his mind all the time and provides opportunity for sanitation, I do not care whether it is fixed or removable, the work will not be a failure.

If you will pay attention to what Dr. Orton has said, and carry out his ideas of application, of technic, and of construction, you need not be afraid of failure whether the structure be fixed or removable.

W. D. Moore, Chicago: I want to compliment the essayist upon the splendid paper he has given us and the many cardinal points discussed. In the first place, he spoke of the necessary training and preliminary instruction that make it so important for the competent crown and bridge-worker, and while colleges cannot do much more than teach these ideas they are very important in developing a good crown and bridge man. When we come out of college we see nothing but a space with teeth on either side. The first thing I see today is the whole mouth. We must determine from a survey of the mouth not only the type of fixture and the kind of abutments but the whole structure required. Success in this work depends upon a careful survey. We have been too short-sighted and have simply seen the one place in the mouth that has lost some teeth. A patient recently said to me, "I would like a bridge put on this side of the mouth. The present one constantly comes loose and I cannot get along." On the other side of the mouth there was a more distressing loss of teeth, one upper molar dropping into a space below locking those jaws and the other side so elongated that there was scarcely room for enough thickness of material to stand the stress of mastication. The whole mouth had to be changed before success could be assured.

Dr. Orton spoke about the tipping of teeth and the tipping occlusal planes, and these are most important points in restoring a mouth to usefulness. I saw some cases in which this was absolutely reversed. These are the things which have done fixed bridge-work an injury, and when it comes to fixed and removable bridges, that must be determined by the operator who knows the conditions in the mouth. The same condition holds true with the different types of adjustments and attachments—they must be determined by what the adjacent teeth present.

T. B. Hartzell, Minneapolis, Minnesota: I have followed with sympathy and attention the effort of my confrere thru a series of years to create a system of diagnosis that would enable the students of dental schools to go out into the world and practice with clearer insight and more perfect vision this art. He has been under a very great handicap, a handicap which I fear obtains in many colleges, an unsympathetic environment. I only need to point to our own school, in which the teaching in crown and bridge-work is fifty hours less than in the previous three-year course, and we now have a five-year course. Could there be anything more discouraging to a painstaking

teacher than to be rewarded in such a manner for his time and effort? I fear that I am to blame to some extent for assisting in the creation of an atmosphere in dentistry which has led men away from bridge-work. I need not dilate on this subject, for you probably all understand exactly what I mean. I am sure, however, that the balance of judgment will slowly swing back toward sanity, and I am convinced of it by much contact in the recent years with men in different cities.

The outstanding feature of Dr. Orton's paper is the fact that he has attempted and succeeded in pointing out the necessity for thoro diagnosis, for seeing the whole truth and not a part of it, and he has very aptly called your attention to the truth that a fact torn loose from its setting, while in that setting it may teach a great truth, may teach a great lie when put by itself. I hope that will compel you all to weigh the varying influences that enter into correct diagnosis and that it will enable you to study and see clearly all the phases of our problems instead of seeing, as all the gentlemen have said, the mere space to be filled by a bridge, and, as a gentleman behind me said, the fee.

If we could have a system of diagnosis that would lead us to see clearly all of the factors in every equation of this kind very few mistakes would be made as compared to the present time.

The dental profession is in a stage of great progress. I think the orthodontists deserve the greatest credit for having established a system of diagnosis which will enable them to classify and teach each and every condition as it merits. I am making in my own field a struggle to stimulate my confreres to adopt a system of diagnosis which will enable them to decide as to when they may justly retain the teeth and when they may justly remove them, and to understand that we must thoroly examine the whole system of physical diagnosis. The sooner we realize that we must know the whole subject and must consider the whole field, just that soon will our profession move toward a greater usefulness.

L. J. Weinstein, New York City: What is the outstanding reason for the failure of bridge-work in the hands of the dentists in this country who are a little below average? The reason is the commercial dental laboratory. That is the cause of the poor restorative work. It is an incentive to malpractice dentistry, and I know whereof I speak; I have conducted one of these for a great many years. The story is told of the dentist in New York who sends a model to the laboratory and says: "Make a set of teeth for a middle-aged lady and make the teeth small and white." That it partly a joke and partly not. The facts are these: Walk into a dental laboratory in Chicago—and I have a great respect for Chicago because there is no other city where there are so many good dentists—and I venture you will find many sets of teeth in their workshops that are made on the same cusp plate—the cusp plate of Jones or Smith, or whoever it may be. What is the matter with fixed bridge-work? To answer that would be impossible because there are a thousand things the matter with it. If the individuals were properly taught in their college days to construct anatomical fixed bridge-work and provide means for sanitation, and not permitted to send the work by messenger or mail to some laboratory, it would help much. The question arises whether the patient is not infinitely better off with a poor removable bridge than a poor fixed bridge. They can, at least, get away from the poor removable bridge and take it out and clean it. Incidentally, there has been sounded in recent months the death knell of "shimmy bridge-work," if you know what that is, on the ground that it does not stand up, that it is flimsy. You have had presented the reasons why "shimmy bridge-work" is inadequate. I have no words with which to express my appreciation of the years of study, and research, back of Dr. Orton's findings. The whole proposition resolves itself into the question of scientific training. Unquestionably the colleges will do better in the future if they do not try to eliminate fixed bridge-work on the ground that it is inadequate, except the many living individuals with crude examples. Is the student in the dental college today so equipped that he can be taught all the elements of scientific removable bridge-work immediately? He must be taught the first steps, even if they are bad.

It seems that we have a greater problem even than fixed bridge-work. We have the postgraduate college. Some of you probably know that I am responsible for what is now known as the Columbia Department of Dentistry, a department which was started with ideals but which has deteriorated into a purely commercial means of providing money for an undergraduate dental school with such small ideals that it cannot even attract undergraduates. It has been the hope that some postgraduate school would act as a clearing-house for the dentists of the country, as an institution that would help to establish duplicate institutions in other parts of the country, because it is infinitely easier for Mohammed to go to the mountain than for the mountain to go to Mohammed. Four years ago Dr. Orton started his work as a bridge specialist to establish his ideals in crown and bridge-work. Why has this fallen? Because of lack of support. One man cannot be expected to carry a burden like that, and it is my firm opinion that if you want practitioners to do better work along these lines there must be some more concentrated effort to educate the

profession both to the evils and the joys of this type of work.

Dr. Orton (closing): Dentistry, like many other things, does not advance *en masse* but a little here and a little there. Crown and bridge-work has not had the same opportunity as has the other branches of dentistry. It has not had in the majority of colleges a separate staff teaching crown and bridge-work exclusively. It was usually hitched up with prosthetic dentistry. Prosthetic dentistry in itself is a great art and required the attention of the men who are teaching it. Their attention cannot be divided by teaching two great arts; consequently, prosthetic dentistry is taught. If there is any time left the students are taught to make bridges. The National Educational College allows something like three hundred for crown and bridge-work and it occupies about 23 per cent of the time of the colleges. When I give statistics, I hope you will realize I have collected them. A questionnaire was sent out as to how many men were teaching crown and bridge-work. Exactly twenty colleges answered. Many said no man; six said one man; four said two men were teaching. Two men teaching crown and bridge-work to fifty students—both the technic and the practical application! How much real teaching could they do? They could not O.K. all the necessary steps much less give any real instruction. We do not learn technical procedures by hearing about them, any more than we can learn to play the piano by a correspondence course. We learn by seeing and doing. That is the way our primitive ancestors learned, the way our children learned and the way we learned. The student has very little instruction in crown and bridge-work as compared with prosthetic dentistry or even orthodontia. I am not criticizing the teachers—the wonder is not that they have not done any better but that they have done so well. I think the thing to realize is that we need drill, drill, drill, the same that makes operators. How much supervision did you get when you started to make crowns? Compare with that the supervision you got when you started to make fillings. We have not had a place in the sun—not the fundamental opportunities—the men have not had the instruction in the colleges.

I have something to say about the laboratories. I think they have been abused. The laboratories are a good index of the type of work of the men in that community and if better work is demanded the laboratories will furnish it. Wherever better work is demanded, there is a laboratory that will do better work. As a rule, the laboratory man will do better work than the dentist. As regards artificial dentures, the laboratories have one man who does nothing but pack rubber and another that does nothing but wax up the teeth. All they do is to supply the demand and we should not blame the laboratory for our own shortcomings. On the other hand, I think they might be used to reduce the cost of dentistry and therefore make dentistry available to a larger proportion of people. Every laboratory man has had to meet the problem of reducing cost and has done it by quantity production.

Dr. Weinstein mentioned the fact that I have tried to urge the standardization of method. I wish to correct that statement. There is no use in trying to standardize a method, but it is possible to standardize true principles.

INDUSTRIAL DENTISTRY AND THE DENTAL PROFESSION

By THADDEUS P. HYATT, D.D.S., New York City

(Read before the National Dental Association, Boston, Massachusetts, August 23-27, 1920)

THE opportunity for systematizing dental procedure on a large scale is offered to our profession thru the establishing of industrial dental clinics thru the country. For this reason, and also because of the opportunity to organize a comprehensive program of preventive dentistry, our profession, as represented by local, state, and national associations, should take some official action that will bring this work into closer relation with the profession and to a certain extent provide some jurisdiction over its activities. This jurisdiction might simply take such form as co-operating with corporations and helping them secure good men to oversee and carry on the work, and also to assist in planning the work that should be done.

Industrial dental clinics offer a more promising field for the securing of clinical facts and figures than can be secured by hospitals or dispensaries, because, as a rule, the patients are under observation for a longer period of time.

Most of the corporations starting dental clinics have already well-organized medical departments, which can and do co-operate with the dental work. The records kept should include both dental and medical findings.

It is very desirable, while the industrial dental work is young, that a uniform method of work be adopted, as far as this is possible and uniform charts be used which could be sent to a central bureau so that the figures and information secured would be reliable and valuable. This cannot be done if the different clinics adopt different charts and record different data. Every dentist in charge of an industrial dental clinic would have greater confidence in his work if he knew that the local, state and national dental associations stood sponsor for him, and his records would bring greater credit to his work because of the uniformity of all records in other industries.

The fact that the dental profession is interested in a practical way in the work being done in the industries will give the dentist in charge a better prestige with the officers of the companies. In fact, if our profession takes the initiative in this matter, it will be in advance of the medical profession, as I do not believe the medical profession has as yet taken any action in the matter of industrial medical work. That it is losing wonderful opportunities for securing valuable information is well known.

It will be well to define the purpose and scope of industrial dental clinics: (1) They should be established for the purpose of educational work among the employees; (2) their work should be largely confined to preventive dentistry rather than to reparative work; (3) prophylactic treatments, examinations, and X-rays properly belong to the preventive and educational branches;

(4) employees should go to outside dentists for all operative work of any kind, extractions, fillings, restorations, etc.

Benefits of Industrial Dental Clinics

Many persons receive proper prophylactic treatments who would otherwise never have received them.

The cleaning of the teeth acts as an incentive to many to have other necessary dental work done as well as to make the proper dental toilet every day.

There is a greater opportunity for preaching the gospel of clean teeth to greater numbers because of these clinics and also by the means of the publications distributed among the employees.

The industrial dental clinic acts as a time and money saver to the dentist as well as to the patient because it educates him to an appreciation and understanding of dental service.

Greater co-operation between the medical and dental professions is secured than is possible between private practitioners.

It gives the employees the opportunity for a proper cleansing of the teeth at regular intervals.

It insures the careful examining and X-raying of suspected teeth.

Industrial dental clinics should form an integral part of the oral hygiene campaign for the teaching and practice of preventive dentistry.

Industrial medical departments are incomplete without a dental clinic, and the two together can render better service and are a great help to persons to regain and maintain health.

By regular medical and dental examinations many serious illnesses are warded off. The patient is in most cases unaware of any serious disturbance being threatened.

Production is increased thru good health and greater efficiency. Industrial medical and dental clinics act as organized centers of observation, and diagnosis, which would be very hard to establish or maintain among general practice.

Some of the practical results obtained by the dental clinic of the Metropolitan Life Insurance Company are as follows:

1. It has been proved by actual figures that the class of employees who received prophylactic treatments when the dental clinic was first opened and who have been coming regularly twice a year have the largest percentage of perfectly clean mouths, the largest percentage of fairly clean mouths, and the lowest percentage of unclean mouths. It is noticed also that the majority of those in this latter class are those having crowns and bridges.

2. The use of lime water as a mouth wash is beneficial and has been the means of changing many unhygienic mouths into the fairly clean and perfectly clean class, and also has changed many of the fairly clean into the perfectly clean class. We have no record of a single case that has been changed from the clean into the fairly clean class or the unclean class.

3. The improvement in health has been sufficiently marked so that the officers of the company appreciate it and have established a new rule, as follows: "The services rendered by the dental division since its establishment in 1915 have been so curative of impaired health conditions and so permanently helpful to the employees who have taken advantage of the opportunities offered, that henceforth every home office employee will be required to undergo examination and cleansing of the teeth in the home office dental division twice a year. If the services of the family dentist is desired rather than that of the home office dentists, such examinations and cleansings by him will be accepted, but they must be procured without expense to the company and the employee must furnish a satisfactory certificate from him that the required work has been done."

Figures are given showing the beneficial results obtained by regular prophy-

lactic treatments and also figures showing results obtained by the use of the lime water mouth wash. The employees using the dental division have been divided into four classes, as follows: Class 1, those who first came in 1915 and have continued to come; Class 2, those who first came in 1916 and have continued to come; Class 3, those who first came in 1917 and have continued to come; Class 4, those who first came in 1918 and have continued to come. By our system of recording, we describe the condition of the mouth as "clean" with the headings "Yes," "No," "Fair."

The following table, given in percentages, should be of great interest to all:

	Yes	No	Fair
Class 1, started in 1915	27	25	48
Class 2, started in 1916	25	27	48
Class 3, started in 1917	18	29	53
Class 4, started in 1918	10	50	40

This table shows, (1) that Class 1 is highest under "Yes" and lowest under "No," (2) that Class 4 is highest under "No" and lowest under "Fair" and "Yes"; (3) that the classes show a gradual graduation toward improvement according to the number of years attending in our clinic.

A study of Class 4 gives the following percentages:

	Yes	No	Fair
First visit in 1918	10	57	33
Second visit in 1918	14	33	53

This shows a gain of 4 per cent in "Yes", a gain of 20 per cent in "Fair" and a loss of 24 per cent in "No."

During one year more than eight hundred employees used lime water as a mouth wash; 80 who were recorded as not clean before using the lime water are now recorded as clean; 249 changed from not clean to fairly clean; 153 changed from fairly clean to clean; there were 96 who had clean mouths so no change could be expected among them; 172 have remained fairly clean, while only 53 have not changed from the "not clean" class.

Tests conducted under the direct supervision of Dr. Neveloff of our clinic showed that the rotary method of brushing the teeth is more efficient than the sweeping method. It is also well recognized by school principals and teachers that the rotary method is more easily taught and learned.

The advantages that might be gained for the oral hygiene campaign by teaching a uniform method of toothbrushing thruout the country are such that it seems a thousand pities not to secure the cooperation of all oral hygiene committees and industrial dental clinics.

This should not be understood as intending to deprive any dentist in private practice from teaching special methods of mouth care for special cases, but for publicity work a simple and an efficient method should be taught which can be easily learned.

In conclusion permit me to impress upon you the desirability and importance for our profession as represented by the National Dental Association to be officially interested in all dental work in hospitals, dispensaries, and industrial dental clinics to the end that there may be uniformity of work done, service rendered, and results achieved.

Discussion

Carl E. Smith, Akron, Ohio: A few years ago, workmen's compensation laws were passed by legislatures of various states. This was followed by the establishment, in industries, of the dispensary for care of the injured and physical examination of new employees. This, of course, brought the physician into industry, and it was only a short step to medical supervision. The physician soon recognized the necessity of having a dentist on whom he could depend for consultation and assistance in the

health work. This in brief accounts for the existence of the dentist in industry. Most of these clinics, medical and dental, are exactly where they were five years ago. They are not giving to industry or the profession all that there is to be procured from medicine and dentistry. The men in charge of these clinics are therefore casting away a wonderful opportunity.

In regard to records and their standardization, I have attended meetings and heard this subject discussed for hours by medical men representing many industries, and my conclusion is that it cannot be done. A physician who is the health director in one of our large concerns says: "Most corporations that have dental clinics or medical departments have men operating them who are not particularly interested in the finer methods of diagnosis or of an operative technic as it pertains to the prevention of disease, and until medical men and dentists of a caliber sufficiently large to handle medical work, as it should be handled, are installed in industry, no great good can be expected from their preventive work. The individual case is too often the basis of reports rather than a larger series of cases, and the conclusions are too often faulty, due to the lack of training in work of this kind of the professional men engaged."

Uniform methods of recording dental and medical work can be instituted only so far and no farther. The reports may be systematized to some degree as a basis, but every individual has his own methods which he follows, especially as it relates to his particular industry and the things he wishes to know.

I would like to ask Dr. Hyatt just how and where this chart is to be used, were it possible to adopt a standard. Would it be used during the physical examination of new employees or at the time they come to the clinic for relief of pain. If in the former case it could not be used in a concern which employes from three to four hundred men because it would take a large force of dentists and assistants to make these examinations. The cost would be prohibitive and officials of the company would not agree to this expense in order that the dental profession might have these statistics. It would also prolong the physical examination, which for various reasons must be conducted rapidly. Suppose this chart which the essayist suggests were to be used when the employee reports to the clinic for relief of pain. For the past year we have had about eighteen hundred cases a month. One of the objects of our clinic is to relieve pain promptly so that the man can return to his job. As long as the clinic does nothing to interfere with production it is popular with foremen, superintendents, and officials. The time taken to make out complicated charts would be lost time to the concern, and this must be avoided if the clinic is to be a success. It occurs to me that the essayist is trying to prove facts by statistics, which more properly belong to the field of research.

The medical profession has recognized industrial medicine and there is an association formed of several hundred members known as the American Association of Industrial Physicians and Surgeons. The Ohio branch is now being formed, whose constitution admits industrial dentists to membership. Such men as Vaughn, the Mayos, Crile, Barker, Cabot and others are decidedly interested in the development of the work.

I agree with the essayist regarding the purpose of the industrial clinic. A great deal of good can be accomplished by educational work, but in placing a limit on the scope he does not give the dentist opportunity to create an interesting position for himself. If my work were limited to prophylactic treatments, examinations, and X-rays I would have returned to private practice long ago. Placing this limit prevents good co-operation with the physician or medical department. Sending patients, especially those suffering from systemic disease, to local practitioners is often disastrous, because patients cannot be depended upon to follow instructions. It is difficult to persuade the laboring men to go to the high-priced specialist. He is unable to understand why one dentist cannot extract a tooth as well as another; he will go to the quack, who does not remove the granuloma, and the patient continues to suffer. If this work is not treated properly in the clinic the medical man soon conceives the idea that focal infection is of no importance.

In regard to fillings and other restorations, if an employee is suffering from a focus of infection I do not believe it a good idea to take a chance on his falling into hands not especially interested in his case, thus having another focus of infection placed in his mouth. Cases should be handled from beginning to end in the clinic.

In regard to the benefits of industrial dental clinics we have three points to consider: (1) the value to the corporation, (2) the value to the employee, (3) the value to the profession. The first is the most important, but in order to establish this value it would be necessary to go into the subject of medical supervision, accident prevention, and health hazards. We must therefore admit the necessity of medical supervision. Physicians in charge of these health departments find the dental clinic an indispensable part of the health work.

The essayist has covered very well the value of the clinic to the employee. However, it can be made more valuable by extending the service to include extraction. If operated in connection with nerve blocking time is saved and pain alleviated. Employees usually pat-

ronize incompetent men for this work, with the result that they return to the clinic with roots left in the jaw, infected and painful sockets, and lacerated tissues, which necessitates their absence from work for several days. These clinics can be made self-supporting. The laboring man does not want charity and our clinic has been more popular since it has been placed on a fee basis. The fees for all operative work are moderate and are about the same as those charged by our younger practitioners; operators are, however, allowed to determine their own fees, just as if they were in private practice. The fee for an ordinary extraction under nerve blocking is one dollar for the first tooth and fifty cents for each additional one. First aid for relief of pain is free to the employees, but these treatments and subsequent treatments for all operations are charged to the department in which the patient works at the rate of one dollar for each treatment, the clinic receiving credit. This is done because the department ordinarily would have to allow the patient to go to a local dentist and it would cost more than a dollar in time lost. For X-rays the fee is fifty cents. The fees for extraction and X-ray are kept on about a cost basis so that the employee will not hesitate to have this work done.

The essayist speaks of the value of the clinic to the profession only as a source of statistics. There is the opportunity for study, experience, and advancement for the man in charge. During the past fourteen months my associates and myself have taken special courses. Knowledge gained in this way is passed on to all operators in the clinic.

We have practically all officials of the company as patients and they appreciate the service the clinic offers. They are busy men and their time is valuable to themselves and to the company. For the young graduate this presents a splendid opportunity to prepare himself for private practice or to take up the work with other industries. The medical man when he leaves college usually serves an interneship in hospitals; the dentist does not have this opportunity to perfect himself and too often makes a failure because of lack of self-reliance. This is soon developed thru the handling of hundreds of cases in the industrial clinic.

The dental profession is allowing good material to go to waste thru lack of interest in the young graduates. If they do not have the support to start in private practice they find their way to the quack, and there are hundreds of young men in these offices who, had proper interest been taken, could have been placed where they would turn out to be valuable members to the profession. There are certain advantages to the local profession which have not been brought out by the essayist. In our city of 225,000 inhabitants we have three well-equipped clinics and will soon have a fourth. These four concerns employ about 60,000 people. It is not difficult to grasp the idea that these clinics are creating a demand for better dentistry. For example, the clinic is consulted regarding other members of the family. When a case is referred to a local practitioner the character of service required is first taken into consideration. If a specialist is indicated the reason for his selection is explained; if a general practitioner, one of the young men whom we know to be conscientious is selected. Thus the profession and the public have been benefited. When these clinics were started there were no specialists in the city; now there are many and they are satisfactory. One of my associates had never taken much interest in plate work until he took a course under Dr. House. He resigned his position and registered for two or three more courses. Now he is supplying a long felt want, because we did not have a man in the city willing to admit he knew anything about the subject. The orthodontist is a help to the clinic because we were glad to have a place to send inquiring parents, and in a very short time he had a large practice. We have several extraction specialists, all with large, well-paying practices. Three years ago one of these men hesitated before making the decision, because people had not been educated to the idea of the specialist. He admits that the clinics were largely responsible for his early success.

Young men in general practice have obtained a start in an incredibly short time. These clinics are all equipped for X-ray work; ours has a full-time technician. Patients are often sent to the clinic for extraction, and subsequent treatments, with a request that dressings be changed. There has been no objection made to the work of the clinic by men who are trying to uphold dental ethics. Men using slipshod methods, and who are constant violators of the principles of good dentistry do not like the industrial clinic.

Charles M. Dunne, Norwich, New York: Dr. Hyatt has emphasized every point that justifies the industrial clinic. From a personal standpoint as an American citizen and a man that believes in a democratic government, from the standpoint of an ordinary lay dentist and a man that believes that personal ability and personality should win in this life-struggle, I cannot agree entirely with Dr. Hyatt.

It is not the duty of any organization, either civic or industrial, to take any step or any decided program on dentistry that is not first sanctioned by the district, state and national associations. Upon first thought, industrial dentistry seems to be a very wonderful thing, but upon second thought I can see where it is possible for industrial dentistry and industrial medicine to work in and grip the very

vitals of our country's government, and it is for this that I believe that the harm done, if carried out to the letter, would be greater than the good derived from it.

Just because the medical profession is taking up this industrial work with a vengeance, it does not follow that dentistry should do the same or that they are right and we are wrong.

Industrial clinics should be inaugurated so that they may establish a work of education among the employees, and that their work should be largely confined to preventive dentistry rather than reparative work. We are doing exactly what this country does not sanction when we give to the people something for nothing. I believe in education; I believe that we should educate the industrial people of this country in every possible way, but I do believe that our work as a profession should stop there, that is under the management of any industrial institution. Cleaning teeth, making examinations, and doing X-ray work is perfectly proper, but how many of the industrial clinics in this country are confining their work to just this? Are they not doing all kinds of general dentistry; are they not doing work the man across the street is waiting and ready to do? The dentist is in competition with his fellow-dentists but he cannot compete with the industries. He has spent his time and money in learning his profession and establishing a practice, and the establishment of an industrial clinic has wiped out his practice, making the years spent in college utterly useless, making it necessary for him to pick up and move to another place and establish another practice, perhaps with the fear of the same thing recurring. If the theory is right for one industry it must be right for all.

Dr. Hyatt's paper very beautifully describes the prophylactics of an industrial clinic. That is as far as he goes and that is as far as an industrial clinic should go. My advice to the district, state and National Dental Association is to curb any act whatever that may tend toward carrying industrial dentistry further into dentistry than is suggested by Dr. Hyatt. It is absolutely against the teachings of our government; it is against the theory that all men are created equal, and it is dragging our profession down to the level with the tradesmen. Let the medical profession hire out if they please to these organizations, but I say to the dental profession let us keep our skirts clean; let us have some regard for our name and the reputation that we in private practice strive for. If these industrial clinics are carried out as thoroly as 95 per cent of them are, and all kinds of dentistry done in these clinics, it simply means that they are doing dentistry and giving it to their employees, not because they love their employees, but because by so doing they can hire their employees so much cheaper.

This government does not advocate the giving of anything without some effort in return. The theory of industrial dentistry, the theory of industrial medicine, the theory of the industrial store, the industrial cafeteria and the industrial buying power is socialistic, pure and simple, and we are near enough to socialism now without a profession as high as dentistry placing its stamp of approval upon its work.

E. L. Pettibone, Cleveland, Ohio: Dr. Dunne is very wrong in his attitude toward the industrial dental dispensary. I know whereof I speak too, altho I am not engaged in industrial dentistry nor do I work for any corporation. I have made a very thoro survey of industrial dentistry, have met most of the men engaged in this work, have helped them perfect an organization of industrial dentists, and have visited most of the larger plants.

The number of plants taking up this work is doubling each year and will continue to do so. Industries are fast learning to care for their employees in a sort of paternal way. The last fifty years were spent in perfecting machinery and the next will be spent in perfecting the human machine. A dental dispensary is used to help in this perfection—increase the man's efficiency.

Every firm that I know has started out with the idea of doing educational work only, namely, a lecture followed by examination and prophylaxis, and in every case where more than this is done it has been necessary because of the wretched work done for the employees by outside dentists.

It is my pleasure to be a member of the Public Health Committee of the National Safety Council, and I want to appeal to you for material for use in bulletins to go to the four million and a half people in the United States that are reached thru their shop bulletins. If you have any material which can be used for this purpose, you cannot devote it to better advantage than to put it where more than four million men will see it.

A. Timmerman, Amsterdam, New York: I have been devoting much of my spare time and energy to mouth hygiene for about ten years and regard the industrial clinics as one of the great boons to the profession as well as to those who have never thought of giving care to the mouth. While I have never had an opportunity of visiting an industrial clinic, as chairman of the Oral Hygiene Committee of the state of New York I was in close touch with some of the earlier clinics that were established.

Dr. Hyatt is very fortunately placed with a class of patients very different from those found in many of the manufacturing plants. There is a great difference between the clerks in an insurance office and the foreign element found in so many of the industries. I firmly believe that a moderate fee charged, whether

sufficient to cover the expense of the undertaking or not, works admirably. It deprives the undertaking of the charity phase and keeps the employee from the gold crown dentist. I also firmly believe that there is no paternalism in the minds of those corporate bodies when the dental clinics are established. Their idea is to hold their staff of employees at their machines and keep them contented.

Some definite plan should be prepared for the different states that are doing oral hygiene work. At present the different states are working along different lines. We need uniformity and if it is directed by the National Dental Association we will get some actual results. I know of no better way than has been suggested, that of taking up the matter of food control for the school children.

H. M. Brewer, Dayton, Ohio: Dr. Dunne has said that he never heard of an industrial institution that carried on the work all the way thru as outlined by Dr. Hyatt. In reply, I want to state that I am associated with the National Cash Register Company of Dayton, Ohio, and we do not carry on the dental work any further than that outlined by Dr. Hyatt.

All applicants for employment are sent to us for a dental examination and they are then sent to the medical department, where a record is kept of the dental and medical examinations. We give each applicant a chart with all decayed teeth marked and urge him to have them filled at once. If we find diseased teeth and broken down roots in the mouth, we invite them to the office to have them extracted or send them to their dentist. We do not reject anybody from employment on account of their teeth unless we find something specific or malignant in the mouth.

Our work consists of examinations, first-aid treatments, temporary fillings, extractions, prophylaxis, and X-ray diagnosis. We do extracting by infiltration only; all other cases are referred. Every employee is entitled to have his teeth cleaned every six months, altho it is not compulsory. There are no charges for any work in the dental dispensary and all work is done on the time of the company. In the majority of cases the prophylaxis is very much needed. We find that the employees are very appreciative of the services rendered.

At our factory we have a Saturday morning entertainment for children ranging in ages from six to fifteen years, with an attendance of about twelve hundred. Recently we had an oral hygiene campaign and examined nine hundred of these children, giving each one a marked chart to take to their parents. We found the teeth of these children in a deplorable condition but the city dentists tell us that many are coming in with the charts to have the necessary work done.

Industrial dentistry does not stop at the factory, for its messages are carried into the homes. We have had the same trouble that Dr. Hyatt had in getting the dentists to fill the small pit cavities that are marked on our charts. The patients are willing but the dentists tell them that they are too small. Did you ever start to drill in one of those little cavities and have your bur slip right in? Yes, indeed, for they are sometimes all undermined with decay. We advise our patients to have every pit cavity filled for that is a great step in prevention.

Epling Welch, West Virginia: Our clinic at the Pocahontas Fuel Company is only for the children of the employees, for the reason that the operations of the Pocahontas Fuel Company are in the great coal region and the Pocahontas Fuel Company supplies a majority of the coal used in our navy. No one company could have continued to do the work of those people if restorations and a large amount of dentistry were being given attention.

I am heartily in favor of industrial dentistry, and we have obtained results from it in that locality. We have an X-ray outfit and thoro equipment supplied by the company. The general manager, at my advice, decided to do the work at reduced rates; therefore the charge is more reasonable than is customary in dental offices thruout that section. But we do not do any work in the towns where there is a regular dentist; it is only in the places where they are almost inaccessible. Colonel Jones, the general manager, started the clinic at his own expense, but the company has taken it over.

After we had conducted the clinic for three years we decided to locate one in the next county, McDowell County, and extend the work at the public expense. The county raised $60,000 a year. The Pocahontas Fuel Company is still retaining its operative work. I have been made director of the McDowell County clinic and still retain my other position.

We should carry on the work in the public schools. The public-school department should be made a part of the dental department. They should co-operate. By the introduction of this dental school the child accepts this service, not as a pauper, but as a child who goes to the grammar school, the public school, or the state normal school; it is not a charitable institution.

Our plan, which was started in the mountains of West Virginia, would be a good one for the counties to follow.

Colonel Jones and myself proposed this bill and we separated it entirely from the medical department, as we did the dental department in the Pocahontas Fuel Company. The school department has co-operated with us just the same as the medical department.

The industrial clinic is a great thing for the people and the locality in which it operates, for it educates patients to go to the other dentists.

Dr. Hyatt: We must remember that industrial dentistry is a young, vigorous, growing infant and it should receive some paternal recognition, direction and affection.

I don't know just why everybody thinks that the employees of the Metropolitan Life Insurance Company are so distinctly a separate group of highly educated Americans, different from those found in other industrial dental clinics. We have men who are working in the building department, including painting, decorating and such things, and we have porters and women who do the scrubbing and washing of floors, and we have the commissary department with many waitresses and such employees. So what has been done in the Metropolitan dental clinic can also be done in every other industrial dental clinic.

To those dentists who feel that there is danger of too much paternalism, I would only say in reply why not consider public education of our children as paternalism. But who would dare to even suggest abolishing the public schools? If it is important to have healthy minds it is equally important to have healthy bodies. If a child with smallpox is not permitted to go to public school then one with bad teeth and a dirty mouth should not be allowed to attend. If it is proper to protect children from smallpox by health authority it is also proper to give dental care.

Dr. Smith seems to be afraid of the time necessary for making out the records of the employees. It only takes us from three and one-half to four minutes to make a record of the dental condition of the mouth.

On the reverse side of our charts, the medical examination and the rest room records, are recorded. We have been able to secure some very interesting figures in regard to systemic conditions as related to mouth conditions. We picked out one thousand charts showing no teeth with non-vital pulp and one thousand charts showing teeth with non-vital pulp. By these records we were able to show a large increase of systemic troubles among persons having teeth with non-vital pulp. When there was an increase of from 19 to 164 per cent of systemic troubles among patients having teeth with non-vital pulps as compared with those that did not have such teeth, the medical department were indeed surprised.

Dr. Dunne remarked that if we were allowed to establish industrial dental clinics thruout the country we would soon be ruling the whole government. I wish there were a chance! The first thing we would do would be to have an oral hygiene clinic established in every public school in the United States of America. Then there would be no need for industrial dental clinics.

In conclusion, I ask of you to take some official action regarding the filling of initial cavities. We might continue to present papers, but if no action is taken little will follow.

A MODIFICATION OF TECHNIC FOR RADIOGRAPHING UPPER MOLARS

By C. A. LeMASTER, D.D.S., St. Louis, Missouri

JUST two factors enter into the production of a dental radiogram: Proper technic, including exposure and development, and correct angle. While the first will be subject to the personal views and preferences of the individual roentgenologist, and may vary within considerable limits without in any manner impairing the diagnostic value of the radiogram, the latter, that is the angle of incident of the Roentgen rays in relation to the film and tooth, may not vary in the least without seriously detracting from the value of the radiogram.

The well-known law which governs this may be concisely stated: The angle of incident of the normal ray shall strike

at right angle the plane which exactly bisects the angle formed between tooth and film—a law to which there is no exception.

In considering this rule, we readily learn the reason which renders the making of a radiogram of the upper molar area exceedingly difficult at times; namely, the shadow of the zygomatic arch and the lower margin of the maxillary sinus are often projected over the molar roots, a situation which occurs

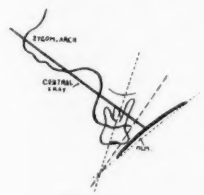

Fig. 1

Fig. 2

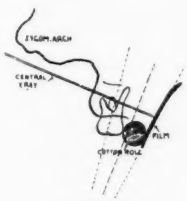

Fig. 3

Fig. 4

with annoying perversity precisely in those cases where a clear image of those roots is very important. Figures 1 and 2 illustrate this.

Various measures have been suggested to overcome this difficulty, all of which may be classified under one group—the deliberate producing of distortion, in such a manner as to throw the suspected area clear from these shadows. This, to be sure, will often furnish a radiogram of sufficient diagnostic value, but unfortunately the relation of the various structures of the tooth appear at times distorted to a confusing extent. Rather than do this a radiogram is very frequently taken in normal position, and just as frequently some important diagnostic features are entirely overlooked.

In trying to find a method which will obviate this difficulty, I have come to the conclusion that it will have to be attempted, not by modifying the angle of incident of the Roentgen rays, but by modifying the *angle of the film to the tooth.* Figures 3 and 4 illustrate the result of this procedure probably more easily than a lengthy explanation would. To sum up briefly: By placing the film into position approximately parallel to the long axis of the tooth to be examined, it will be possible to direct the Roentgen rays below the zygomatic arch and antrum (maxillary sinus), entirely eliminating their overlapping shadows.

In practice this is done by attaching a medium-sized absorbent cotton roll to the lower edge of the film, and the patient is instructed to place his finger near the upper edge of the film, pressing it firmly against the palate. This will result in bringing the upper portion in close apposition to the apex of the roots, while the lower portion is removed from one-half to one centimeter from the crown of the tooth. The apices of the roots are clear and free from superimposed shadows and yet in perfect proportion to the tooth itself and to the surrounding process.

COLLECTING AND MAINTAINING A DENTAL MUSEUM AND LIBRARY

By WILLIAM BEBB, M.S., D.D.S., Chicago, Illinois

(Read before the American Dental Library and Museum Association, Boston, Massachusetts, August, 1920)

THE first and probably the most important requisite for the making of any collection is an individual possessed of the spirit of a collector, a person endowed with an insatiable desire to accomplish a purpose which no amount of delay or discouragement can allay. In adult life, collectors in given fields are rare, but nearly all children, especially boys, are possessed with a desire to collect. They collect postage stamps and coins, birds' eggs and stones, or anything which appeals to their fancy. If this childish trait received encouragement and direction, there would be no dearth of adult collectors. But parents rarely take an interest in helping the child, usually because of failure to appreciate the practical value of such an effort. If the director of your museum and library is one of these rare individuals he may still lack one trait; he may not have learned a lesson which is of great importance in the building of a collection. Years ago, long before I entered dental school, I began the collecting of items pertaining to dentistry, but was interested in Coleoptera. I was in the field with an elderly scientist who taught me the lesson. He said: "Young man, when your getting, get." The successful builder of a dental museum and library will collect everything, and I emphasize that word "everything" pertaining to the practice of dentistry. Not only will he collect every variety of specimens and books, but he will gather duplicates whenever possible.

He must expect, if he does this, to meet with disapproval and criticism. We were once accused of having "porcine tendencies" for collecting two complete files of a certain journal. I dare not contemplate what some may think when I report that we have eight complete bound files of the *Dental Cosmos* in our library. I will say in defense that in the assignment of articles to our students for review, we occasionally find that we cannot supply the calls for a certain volume, even with this number, and we are now collecting two more files.

The following is a list of the important items to be collected:

Dental textbooks, old and modern.
Reprints.
Dental supply house catalogues.
College yearbooks, college announcements, college catalogues.
Monthly and annual state society bulletins and programs.
State dental board reports.
Medals and diplomas awarded to dentists.
Dental magazines, old or recent.
Photographs, engravings, or prints of dentists, or pictures relating to the practice of dentistry.
Old dental chairs, cabinets, engines.
Old instruments, appliances and materials, including engine hand pieces and automatic mallets.
Anomalous human and animal teeth.
Human and animal crania, normal and abnormal.
Human and animal bones, showing fracture and repair, or pathological conditions.
Fossil crania and teeth.
Pieces of odd or curious bridge-work, old plates, or fillings.
Specimens of salivary or other bodily calculus.
Impressions or plaster casts of anomalous conditions, such as supernumerary teeth, abrasions, abnormalities of the soft tissue, etc.
Odontomes and other pathological specimens.
Toothbrushes of odd form, and any appliance used in oral prophylaxis.
Extracted teeth with restorations made by dentists of prominence. Plates and bridges made by noted men.

In the collecting of normal animal crania, one must go into the field with

gun and traps if he hopes to be possessed of a series of much importance. Domestic animal heads may be obtained at the neighboring slaughterhouses, from the dog pounds, and from the rendering and fertilizer crematories. Captive wild animals are obtained from the zoölogical gardens by the payment of a fee to some deputy keeper for preserving them. In the larger cities the heads usually go to a city museum but many animals die in the zoos of the smaller cities and are discarded.

In gathering the specimens of a purely dental nature or those to be found in dental offices and supply houses, I have met with indifferent success except by one method and that is to go after them personally. Travel about from city to city, visit the older dentists and the dental supply houses and you will find many rare and valuable items which no amount of corresponding or advertising will unearth. Do not expect to secure many valuable specimens without paying for some of them. If they are valuable to you, pay for them. Of course there are exceptions to this. Certain individuals will send to your museum any specimen they may encounter and other persons will go out of their way to add to your collections. The dental supply dealers and their representatives often take a keen interest in helping one to find valuable items. They are a splendid lot of fellows and if you are to succeed you should gain their co-operation.

One must have suitable rooms for the accumulation of specimens and they should be stored away, accompanied with the correct data, until such a time as they are to be placed on display in the museum or bound for the library.

The collection of old books and prints is best accomplished thru the old book dealers; a constant search for items among the medical books will often result in the finding of some rare volume or print.

You are all familiar with museums and their display methods and should therefore select your show cases to meet individual taste and requirements. Do not be satisfied with cheap display cases. They are as cheap as cheap dentistry. It is practically impossible to secure bids on a type of case with any greater degree of certainty of obtaining a suitable article than it is to secure bids on dental operations. Select a good reliable showcase maker, tell him your needs and let him make your cases. Make it a rule not to display collections until suitable cases are provided. One may see, in many of our dental schools, rare and valuable material fast going to ruin in cases that do not exclude the dirt and dust. It is much wiser to keep specimens stored away in dust-proof boxes unless your school or board of trustees provides suitable cases. Use only the best form of mountings and the best labels obtainable. I would much prefer to visit a small museum well housed than to see a great collection covered with dirt and dust.

Avoid the word "Don't" in your museum room. "Don't lean upon the glass," "Don't throw paper on the floor," "Don't place your feet upon the rails," and many other placards of a similar nature are not only unsightly but unnecessary. The students soon learn your wishes and if your museum and library are well kept discipline is easy of attainment.

A library should be catalogued and shelved according to the Dewey system, the one in use by most general libraries. Certain rare books may be used only as reference volumes, but the items possible of replacement may circulate.

A system of fines for failure to return a book within a given time should be rigidly enforced. No system will positively insure against the loss of books, for the return of a book is considered unimportant by many individuals. However, a good system with a capable assistant in charge will reduce losses to the minimum.

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Editorial Department

"THE SPIRIT OF THE WEST"

It has frequently been stated that this is the greatest country in the world. Commendable modesty, and a due regard for the amenities of life will prevent a too frequent reference to this fact on the part of true Americans, and yet as a plain statement of the truth it cannot be gainsaid. This does not refer so much to the achievements of the people as to the natural resources of the country. In fact it sometimes seems as if the people had not quite lived up to their greatest possibilities in the development of this marvelous land. Nature has spread out

all the things needful for the equipment and happiness of mankind with such a lavish hand that it has too frequently led to an apparent indifference, and even to a wastefulness, which reflects little credit on the American people. Great as the people are, their country is even greater.

One is more and more impressed with this as one travels in different directions. Wherever the people have co-operated with the resources of the country the results have been astonishing.

In the East the products of the soil, gathered from every direction in the form of raw materials, have been transformed by the magic hand of man and of machine into things of beauty and utility, the miracle of the loom and the last.

In the North the rugged virtues have been ingrained into the people by the storm-kings of the ages, the sweeping blasts of winter and the glorious sunshine of summer. The forests, the iron beds, the wheat fields—all have contributed to the virility of the race.

The South is the land of love, of luxury, of chivalry, with its traditions, and its today of enterprise and industry; there the lullaby of the colored mammy is mingled with the hum of the cotton gin, and the hearts of men beat warm for their fellowmen.

And then the West, the wondrous West! What shall we say of this glorious clime? There is magic in the very word "California." From the days when the Spanish monks sailed up its western coast and made their missions, down to the argonauts of '49, down to the orange, lemon, and walnut groves of the South, down to the day when oil gushed forth from the generous bosom of the earth, there is living interest, there is pulsating and abounding life. And with it all, and above everything else, there is romance. No one can contemplate the history of California without being thrilled. One feels this sensation the moment one enters its portals. That entire western slope from the crest of the Rockies downward to the lapping waves and boisterous breakers of the Pacific is a different land. The balmy breath of the Japanese current sweeps over its hills and thru its vales, and tempers the rigors of winter. Nature smiles and smiles, and seldom frowns.

And the people! Ah, here is the crowning glory of California! In consonance with the beneficence of the soil and the climate, there has grown up a race of men with boundless energy and amazing generosity. Hospitality is their other name. They are liberal, loyal, and lovable. They entertain the stranger within their gates as if he were a long-lost brother, and the length of their entertainment is measured only by the length of his stay.

The spirit of the West is manifest everywhere. It is a spirit which has transformed a wilderness into a paradise, and given to the world a

demonstration of what is possible when the bounties of nature are combined with the mind and will of men. Of the many assets of California—its minerals and mountains, its fruits and flowers, its roads and rivers, its climate and cotton, its trees and traditions—the greatest of all is found in the hearts of its own people. They have taken nature in one of her choicest moods, and they have made a miracle of it. All hail! California!

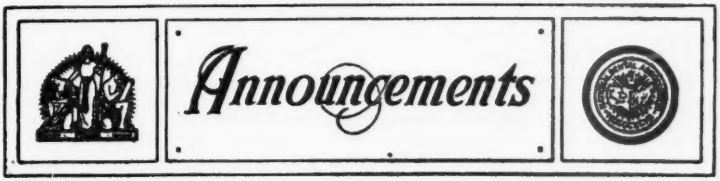
And what may be said of Californians as a whole may be said in double measure of her dentists. They are alive, alert, entertaining, and progressive. They welcome the visitor and they make him feel as if he had always known them. Those who have never been to California should go there and feel the hand clasp of its dentists. Those who have been there should go again. California invites the National Dental Association to meet there in 1922, and the Association could do no better thing than to accept. The slogan of the profession should be—*Let's go. On to California.*

REQUIEM

FOR R. FAMB LEE TOOTHBRUSH

Thou proud survivor of a day gone by,
Thou lordly monarch of the model home,
All hail! Who lives who can suppress a sigh
To see the brother of the family comb—
R. Famb Lee Toothbrush—cast aside for e'er,
That once was used to scrub the kitchen floor,
To black the stove, and brush the puppy's hair,
And father's teeth, and Jim's, and furthermore,
That set of ma's, which soon will fit dear Sue;
To spank the twins; to aid the annual bath,
To scrub the Ford, and make old shoes look new?
Had e'er a life a past as this one hath?
Farewell, thou brave of hard-worked ancient days!
Thy work's well done! Let men and angels praise!

—Dorothy Hawley Cartwright.



CALENDAR OF MEETINGS

NATIONAL SOCIETIES

National Dental Association, at Milwaukee, Wisconsin, August 15-19.

National Society of Denture Prosthetists, at Milwaukee, Wisconsin, August 1-13, Hotel Medford.

National Association of Dental Examiners, at Milwaukee, Wisconsin, August 15, Hotel Pfister. T. A. Broadbent, Secretary-Treasurer, 25 E. Washington Street, Chicago, Ill.

Psi Omega Fraternity, Biennial Grand Chapter, August 10, and National Alumni Chapter, August 15, at Milwaukee, Wisconsin Hotel. M. M. Printz, Supreme Councillor, 25 East Washington Street, Chicago, Ill.

Xi Psi Phi Fraternity, Alumni Association, August 15, at Milwaukee, Wisconsin Hotel. J. Emmett Northcutt, Secretary, St. John and Elmwood Avenue, Kansas City, Mo.

Delta Sigma Delta Fraternity, August 15, at Milwaukee, Hotel Pfister. R. Hamill D. Swing, Supreme Scribe, 1623 Walnut Street, Philadelphia, Pa.

Association of Military Dental Surgeons, at Milwaukee, August 16 and 17. G. H. Cassady, Secretary-Treasurer, Presidio, San Francisco, Cal.

American Academy of Periodontology, May 9 and 10, at Hotel Commodore, New York City. J. Herbert Hood, Secretary, 1011 Guardian Building, Cleveland, Ohio.

American Dental Library and Museum Association, August 15 and 17, at Milwaukee. B. W. Weinberger, Secretary, 40 E. Forty-first Street, New York City.

American Society of Orthodontists, April 27-30, at Atlantic City, N. J., at Hotel Ambassador. Ralph Waldron, Secretary, 549 High Street, Newark, N. J.

American Institute of Dental Teachers, third week of January, 1922, at Montreal, Quebec. Abram Hoffman, Secretary, 381 Linwood Avenue, Buffalo, N. Y.

STATE SOCIETIES

April

Alabama, at Montgomery (12, 13, 14).
Connecticut, at Waterbury (21, 22, 23).
Kentucky, at Louisville (13, 14, 15).
Michigan, at Detroit (11-16).
Mississippi, at Jackson (18, 19, 20, 21).
Missouri, at Springfield (25, 26, 27).
West Virginia, at Bluefield (11, 12, 13).

May

Arkansas, at Little Rock (16-20).
Illinois, at Peoria (10, 11, 12).
Indiana, at Indianapolis (16, 17, 18, 19).
Iowa, at Des Moines (2, 3, 4, 5).
Maryland, at Baltimore (25, 26, 27).
Massachusetts, at Boston (4, 5, 6).
Montana, at Billings (16-21).
Nebraska, at Omaha (16, 17, 18, 19).
New York, at New York City (11, 12, 13, 14).
North Dakota, at Minot (no date given).
Pennsylvania, at Philadelphia (3, 4, 5).
Tennessee, at Nashville (17, 18, 19, 20).

June

California, at San Francisco (June 27 to July 2).
California (Southern) at Los Angeles (20, 21, 22).
Florida, at Gainesville (14-17).
Georgia, at Macon (8, 9, 10).
Idaho, at Boise (June 27 to July 2).
Maine, at Bar Harbor (21, 22, 23).
New Jersey, at Atlantic City, Steel Pier (1, 2, 3).
New Mexico, at Albuquerque (20-25).
North Carolina, at Charlotte (28-30).
South Carolina, at Greenville (no date given).
Utah, at Salt Lake City (21, 22, 23).

July

Washington, at Vancouver, B. C.

August

Wisconsin; no state meeting because of the National Dental Association meeting in Milwaukee.

December

Ohio, at Columbus (6, 7, 8).

MEETINGS OF STATE BOARDS OF DENTAL EXAMINERS

Alabama, at Birmingham, Birmingham Dental College, Avenue F and Twentieth Street, June 20. H. Clay Hassell, Secretary-Treasurer, 616 Twenty-second avenue, Tuscaloosa.

California, at San Francisco, May 21; and at Los Angeles, June 25. C. A. Herrick, Secretary, 133 Geary Street, San Francisco.

Connecticut, at Hartford, June 23, 24, 25. Robert W. Strang, Recorder, 886 Maine Street, Bridgeport.

Florida, at Jacksonville, June 9-13, inclusive. R. P. Taylor, Secretary, 414-15 St. James Building, Jacksonville.

Idaho, July 12. Paul Davis, Director, Bureau of License, Boise.

Indiana, at Indianapolis, June 20-25. H. C. McKittrick, Secretary-Treasurer, 1006 Odd Fellows Building, Indianapolis.

Kansas, at Wichita, June 13. G. F. Ambrose, Secretary, 111½ S. Main Street, Eldorado.

Kentucky, at Louisville, Dental Department, University of Louisville, June 7. J. H. Baldwin, Secretary, Francis Building, Louisville.

Maine, at Augusta, State House, July 7, 8, 9. Henry Gilman, Secretary, 192 State Street, Portland.

Maryland, at Baltimore, Dental Department, University of Maryland, June 7, 8, 9, F. F. Drew, Secretary, 701 N. Howard Street, Baltimore.

Mississippi, at Jackson, Senate Chamber of the State Capitol Building, June 21. Burt J. Marshall, Secretary, Marks, Miss.

Montana, at Helena, July 11. Frank J. Bell, Secretary, P. O. Box 425, Billings.

Nebraska: practical, at Omaha, Creighton Dental College, and at Lincoln, University of Nebraska Dental College, June 7 and 8; written, at Lincoln, State House, June 9, 10, 11. H. H. Antles, Secretary, Department of Public Welfare, Lincoln.

New Jersey, at Trenton, Second Regiment Armory, June 27-July 1. John C. Forsyth, Secretary, 429 E. State Street, Trenton.

North Carolina, at Charlotte, June 25. F. L. Hunt, Secretary, Asheville.

Oklahoma, at Oklahoma City, State Capitol Building, June 6 to 11, inclusive. L. M. Doss, Secretary-Treasurer, 245 American National Bank Building, Oklahoma City.

Rhode Island, at Providence, State House, June 28, 29, 30. Albert L. Midgley, Secretary, 315 Butler Exchange Building, Providence.

South Dakota, at Sioux Falls, June 28, 29, 30. L. R. Walston, Secretary, Redfield.

Texas, at Dallas, June 20-24. Harrison B. Cave, Secretary, Wilson Building, Dallas.

Vermont, at Montpelier, State House, June 27, 28, 29. Harry F. Hamilton, Secretary, Newport.

Wisconsin, at Milwaukee, Marquette Dental College, June 18-25. William Kettler, Secretary, 480 Berlin Arcade, Milwaukee.

STUDY CLUBS AND OTHER SOCIETIES

Alumni Society of the Dewey School of Orthodontia, April 25 and 26, Hotel Ambassador, Atlantic City, New Jersey. Secretary, George F. Burke, 741-43 David Whitney Bldg., Detroit, Mich.

Club of Physician-Anesthetists, second Monday evening of each month, Chicago. Secretary, Frances E. Haines, 1618 W. Adams St., Chicago, Ill.

Detroit Dental Clinic Club, school of instruction beginning April 18. Secretary, E. L. Giffen, 704 Fine Arts Bldg., Detroit, Mich.

Seventh District Dental Society, of the state of New York, April 8 and 9, Rochester Dental Dispensary, Rochester, N. Y.

SOUTHERN CALIFORNIA DENTAL ASSOCIATION

Postgraduate classes will be held June 13 to 18, inclusive.

The annual convention will take place in Los Angeles, June 20, 21, and 22.

BERT BOYD, *Secretary*
1010 Story Bldg., Los Angeles, Cal.

SEVENTH DISTRICT DENTAL SOCIETY

The fifty-third annual meeting of the Seventh District Dental Society of the State of New York will be held at the Rochester Dental Dispensary April 8 and 9. Members of the fifth, sixth and eighth district societies are cordially invited.

F. J. SHADDOCK, *Secretary*

THE AMERICAN ACADEMY OF PERIODONTOLOGY

The eighth annual meeting of the American Academy of Periodontology will be held at the Hotel Commodore, New York City, May 9 and 10, 1921.

J. HERBERT HOOD, *Secretary-Treasurer*
1011 Guardian Bldg., Cleveland, Ohio

SOUTH DAKOTA STATE BOARD OF DENTAL EXAMINERS

The next meeting of the South Dakota State Board of Dental Examiners will be held in Sioux Falls, South Dakota, June 28, 29, and

30, 1921, beginning promptly at nine o'clock, Tuesday morning, June 28.

All applications must be in the hands of the secretary by June 15. Fee for examination, $25.00. No reciprocity or interchange. Full information and application blanks may be received by addressing

L. R. WALSTON, *Secretary*
Redfield, S. D.

OMICRON KAPPA UPSILON HONOR FRATERNITY

The Omicron Kappa Upsilon Honor Fraternity met in Indianapolis in January during the meeting of the American Institute of Dental Teachers. Supreme officers elected are: Dr. Arthur D. Black, president; Dr. H. E. Friesell, vice-president; Dr. J. H. Phillips, secretary-treasurer.

PSI OMEGA FRATERNITY

The annual New York Alumni banquet will be held Thursday evening, May 12, 1921, in the Hotel Astor, at 7:00 P. M. A cordial welcome is extended to all visiting members. Kindly secure reservations in advance.

DWIGHT R. WILSON
414 Madison Ave., New York City

MARYLAND BOARD OF DENTAL EXAMINERS

The Maryland Board of Dental Examiners will meet for examination of candidates for certificates in Baltimore at the Dental Department of University of Maryland on June 7, 8, and 9, 1921, at 9:00 A. M.

For application blanks and further information apply to F. F. DREW, *Secretary*
701 N. Howard St., Baltimore, Md.

MARYLAND STATE DENTAL ASSOCIATION

The Maryland State Dental Association will hold its regular spring meeting in Baltimore, at the Belvedere Hotel, on May 25, 26, and 27, 1921. A cordial invitation to attend is extended to all ethical members.

F. F. DREW, *Secretary*
701 N. Howard St., Baltimore, Md.

MONTANA STATE BOARD OF DENTAL EXAMINERS

The next meeting of the Montana State Board of Dental Examiners will be held in Helena beginning the second Monday in July. Applications must be in the hands of the secretary not later than June 25.

For further particulars apply to

FRANK J. BELL, *Secretary*
P. O. Box 425, Billings, Mont.

FLORIDA STATE BOARD OF DENTAL EXAMINERS

The next annual meeting of the Florida State Board of Dental Examiners will be held in Jacksonville, June 9 to 13, inclusive, for the purpose of examining all qualified applicants. All applications should be in the hands of the secretary not later than June 1.

For application blanks and information address

R. P. TAYLOR,
414-15 St. James Bldg., Jacksonville, Fla.

KENTUCKY STATE BOARD OF DENTAL EXAMINERS

The Kentucky State Board of Dental Examiners will hold its annual examination for license to practice in the state, June 7, beginning at 8:00 A. M., in the Dental Department, University of Louisville. Graduates of A and B colleges, as rated by the Dental Educational Council, are eligible for examination.

For blanks apply to

J. H. BALDWIN, *Secretary*
Francis Building, Louisville, Ky.

INDIANA STATE BOARD OF DENTAL EXAMINERS

The Indiana State Board of Dental Examiners will hold their next examination in Indianapolis, June 20-25.

For application and instructions write to

H. C. MCKITTRICK, *Secretary-Treasurer*
1006 Odd Fellows Bldg., Indianapolis, Ind.

RHODE ISLAND BOARD OF REGISTRATION

The regular semi-annual meeting of the Rhode Island Board of Registration in Dentistry for the examination of applicants will be held in the State House, Providence, Rhode Island, June 28, 29, and 30, 1921. All applications with proper fee must be filed one week previous.

For further information address

ALBERT L. MIDGLEY, *Secretary*
315 Butler Exchange Bldg., Providence, R. I.

ARKANSAS STATE DENTAL ASSOCIATION

The annual meeting of the Arkansas State Dental Association will be held in the State Capitol Building at Little Rock, May 16-20,

1921. Postgraduate instruction will be given by three competent instructors: Dr. A. E. Smith, of Chicago, Dr. E. B. Owen, of St. Louis, and one other to be announced. Other special features will be announced.

W. E. WILLIAMS, *Secretary*
Little Rock, Ark.

NEW MEXICO STATE DENTAL SOCIETY

The New Mexico State Dental Society will hold its next meeting at Albuquerque, June 20 to 25, inclusive. Dr. C. J. Hamilton, of Denver, will demonstrate the Tench method of impression-taking, carrying one entire case thru to completion.

M. R. CHAPIN, *Secretary*
Suite 3-4 Hedgcock Bldg.,
East Las Vegas, N. M.

DENTAL HYGIENE SOCIETY

The Los Angeles County Dental Hygienist Society has been organized. Mrs. G. Buford has been elected president, Miss H. Cramer, vice-president, Miss E. McKinley, secretary, and Mrs. C. Carter, treasurer.

IOWA STATE DENTAL SOCIETY

The fifty-ninth annual meeting of the Iowa State Dental Society will be held at Des Moines, Iowa, May 2, 3, 4, 5, 1921. An interesting clinical and literary program is being arranged, and all ethical practitioners are cordially invited to attend.

E. S. SMITH, *Secretary*
Iowa City, Ia.

THE NEBRASKA STATE BOARD OF DENTAL EXAMINERS

The Nebraska State Board of Dental Examiners will hold its next regular examination June 7, 8, 9, 10, and 11. Practical examinations will be held June 7 and 8 at the Creighton Dental College in Omaha and at the University of Nebraska Dental College in Lincoln. The written examination will be held at the State House in Lincoln, June 9, 10 and 11. Each applicant must furnish his own patient for practical work. For information and applications, address,

H. H. ANTLES, *Secretary*
Department of Public Welfare, Lincoln, Neb.

IDAHO STATE DENTAL ASSOCIATION

The second annual post-graduate course of the Idaho State Dental Association will be held at Boise June 27-July 2, inclusive. The class instructors are: Dr. D. D. Campbell, full denture construction, and Dr. Arthur E. Smith, oral surgery, exodontia, anesthesia.

M. J. GOODE, *Secretary*
Filer, Idaho

WISCONSIN STATE BOARD OF DENTAL EXAMINERS

The Wisconsin State Board of Dental Examiners will conduct a licensing examination at the Marquette Dental College in Milwaukee, beginning Saturday, June 18, and continuing to Saturday, June 25, 1921.

The Wisconsin dental law provides that "no person shall be examined by the board for a license to practice dentistry in this state, who shall not file with the secretary of the board credentials proving to the satisfaction of the board that he has a general education equivalent to that required for graduation from a high school or academy in the state of Wisconsin, having a four-year course beyond that of the eighth grade of the elementary school, and who is not a regular graduate of reputable dental college or dental department of a university."

All credentials should be in the hands of the secretary of the Board not later than June 5, 1921.

WILLIAM KETTLER, *Secretary*
480 Berlin Arcade, Milwaukee, Wis.

BOARD OF DENTAL EXAMINERS OF CALIFORNIA

The next meeting of the Board of Dental Examiners of California for the purpose of examining applicants for a license to practice dentistry in this state will be held in San Francisco, beginning May 21, 1921, at 9:00 A. M. This examination will be followed by an examination to be held in Los Angeles, beginning June 25, 1921, at 9:30 A. M. Each applicant shall file with the secretary of the Board at least fifteen days before the date selected for each examination, the following credentials: (1) a diploma or certificate of graduation from a reputable dental college approved by this Board; (2) a diploma from an accredited high school or a certificate signed by a state superintendent of public instruction (or similar officer) to the effect that the applicant has had scholastic preparation equivalent in all respects to that demanded for graduation from a high school giving a four-year course of instruction. An applicant who has been a licensed practitioner of dentistry of some other state of the United States for a period of five years or more shall file such license in lieu of the high-school creden-

tials; (3) a testimonial of moral character; (4) a recent unmounted photograph of the applicant.

For further information address

C. A. HERRICK, *Secretary*
133 Geary Street, San Francisco, Cal.

ARMY MEDICAL DEPARTMENT

The Secretary of War has decided that no more appointments shall be made to commissioned grades in the Army medical corps, dental corps, and administrative corps, as a result of the adoption by Congress of the joint resolution (440) restricting the enlisted strength of the Army at 175,000. This is considered as placing a limit on the number of commissioned officers in the three branches of the medical department, in accordance with the provisions of the act of June 4, 1920, which specified that the number of officers in the medical corps should be 6½ for every thousand and of the medical administrative corps 1 for every 2,000 of the total enlisted strength of the Regular Army, while the number of officers in the dental corps should be 1 for every 1,000 of the total strength of the Regular Army "authorized from time to time and within the peace strength permitted by" that act. The number of officers of the veterinary corps was placed on an entirely different basis, that of 175 in commissioned strength. It has been decided, therefore, that the reduction in the enlisted strength makes it necessary to reduce the number of officers to 1,138 in the medical corps, 193 in the dental corps, and 88 in the administrative corps, or a surplus of 59 officers, 59 officers, and 51 officers, respectively. Instructions have been issued by the War Department that no appointments in these branches will be made until the surplus in each has been absorbed. This will probably take a year or more, it is estimated, at the rate of present resignations. No action will be taken, however, to deprive any officer of the commission he now holds. It is observed that the existing law permits the reappointment of former Regular Army and retired officers when there are no vacancies, such appointees being carried as extra numbers until absorbed.—*Army and Navy Register*, February 26, 1921.

DENTAL CORPS ORDERS FROM WAR DEPARTMENT

DENTAL CORPS

Majors Samuel Kaufman and George R. Kennebeck from duties in Philippine Department, effective upon completion of present tour of foreign service to Presidio of San Francisco for duty.

Major Chester Denham from duty at Fort Banks, Mass., to Boston for duty as attending dental surgeon.

Major Wilfurth Hellman, Captain Howard C. Feyler from duties in Hawaiian Department, effective upon completion of present tour of foreign service to Presidio of San Francisco for duty.

Captain William H. Hoblitzel from duties in Hawaiian Department, effective upon completion of present tour of foreign service and assigned to duty and station at Presidio of San Francisco.

Captain Harold J. Parker from duty in Philippine Department, effective upon completion of present tour of foreign service, and will report in 9th corps area for duty.

Captain George J. Sibley from duty at Fort Logan, Colo., to San Francisco, Letterman General Hospital, for duty.

Captain Timothy Harden, First Lieutenant Oscar W. Thompson to New York City and about April 10 to Panama Canal Department for duty.

Captain Roy M. Kisner, First Lieutenant Earle Robbins to San Francisco and about May 5 to Hawaiian Department for duty.

First Lieutenant Howard A. Hale about June 5 to Phillippine Department for duty. —*Army and Navy Register*, February 19, 1921.

Major George R. Tressel from duty at Fort Slocum, N. Y., to Carlisle Barracks, Pa., for duty.

Captain Henry L. Hogan from duty at Fort Thomas, Ky., to Fort Riley, Kans., cavalry school for duty.

First Lieutenant Campbell H. Glascock from duties at Jefferson Barracks, Mo., to Camp Pike, Ark., for duty.

Resignation by First Lieutenant Everett H. Ruggles accepted.

Captain George J. Krakow report to retiring board at Fitzsimons General Hospital, Denver, Colo., for examination.

First Lieutenant Joseph H. Jones from duty at Columbus Barracks, Ohio, to 8th corps area for duty.

First Lieutenant James B. Mockbee from duty at Fort McDowell, Calif., to 9th corps area for duty.

First Lieutenant Henry A. Winslow from duty at Fort Slogan, N. Y., to 3d corps area for duty.

Executive nominations sent to the Senate on February 18:

Appointments in the Regular Army of the United States.

Dental Corps—To be captains: J. N. White, W. F. Scheumann, C. H. Glascock, W. F. Wieck, T. H. Veale.

Executive nominations received by the Senate on February 21:

Dental Corps—To be captains: T. L. Spoon, Earle Robbins, R. A. Stout, O. W. Thompson, H. A. Hall and W. S. Shuttleworth.—*Army and Navy Register,* February 26, 1921.

Major Joseph H. Tyler from duties in Philippine Department, effective upon completion of present tour of foreign service, to 8th corps area for assignment.—*Army and Navy Register,* March 5, 1921.

Captain Clement J. Gaynor from duties in Hawaiian Department, effective upon completion of present tour of foreign service, to duty at Presidio of San Francisco.—*Army and Navy Register,* March 12, 1921.

The following promotions to next higher grade in the Regular Army in the dental corps are announced: First Lieutenant Daniel S. Lockwood, to captain, December 11, 1920.

The following promotions to rank indicated were announced March 16: First Lieutenants Earle Robbins, J. N. White, C. H. Glascock, and F. W. Wieck, dental corps.

The following promotions were announced on March 17: Captains Roy A. Stout, Howard A. Hale, Thomas H. Veale, dental corps.

The following officer, having been examined for promotion by a board of officers and found physically disqualified for his duties as captain, by reason of disability incident to the service, retirement by the president from active service, with the rank of captain to date from June 4, 1920, under the provisions of section 5 of an act of Congress approved April 23, 1908, is announced. He will proceed to his home: First Lieutenant Harry Holmes, dental corps, Soperton, Ga.—*Army and Navy Register,* March 19, 1921.

Captain John G. Urban, upon arrival in United States, to Jefferson Barracks, Mo., for duty.

Captain Clarence J. Wright at Carlstrom Field, Fla., is transferred to Walter Reed General Hospital, D. C., for observation and treatment.

Captain Alexander M. Smith, Jr., from duties at Camp Stanley, Tex., to Arcadia, Fla., Carlstrom Field for duty.

Captain Samuel J. Rohde, upon arrival in United States, to Washington Barracks for duty.

First Lieutenant Melville A. Sanderson from duties at Fort Andrews, Mass., to 4th corps area for duty.—*Army and Navy Register,* March 26, 1920.

DENTAL RESERVE CORPS

First Lieutenant Raymond D. Reid to active duty in 7th corps area.—*Army and Navy Register,* February 19, 1921.

Major William O. Boss from duty at Washington Barracks, D. C., to Edgewood Arsenal, Md., for duty.

First Lieutenant John T. Cosler to active duty in 5th corps area.—*Army and Navy Register,* March 26, 1920.